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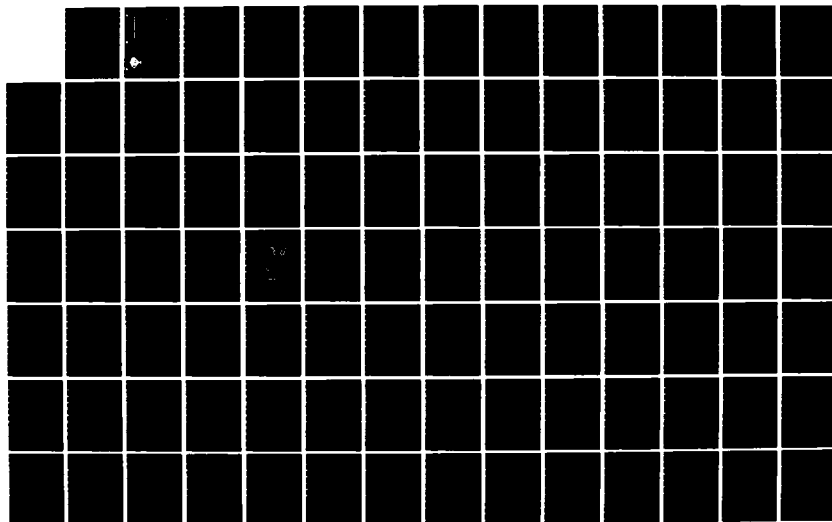
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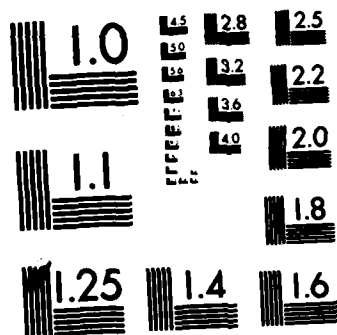
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TRAINING SYSTEMS ANALYSIS & DESIGN

LIGHT ARMORED VEHICLE (LAV)
TRAINING EQUIPMENT SURVEY
FOR THE
U.S. MARINE CORPS LAV-25

15 DECEMBER 1983

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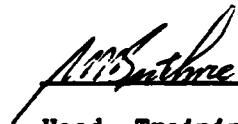
Naval Training Equipment Center
Orlando, Florida 32813

**LIGHT ARMORED VEHICLE (LAV)
TRAINING EQUIPMENT SURVEY
FOR THE
U.S. MARINE CORPS LAV-25**

15 DECEMBER 1983



Head, Land Analysis and
Design Branch




Head, Training System
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NAVAL TRAINING EQUIPMENT CENTER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>➤ This report is the second and final report for the Training Device Requirements Analysis Project. The objective of the project was to provide recommendations on training devices which could be used to train turret operation/gunnery skills and associated operator maintenance on the Light Armored Vehicle (LAV-25). Following a training equipment survey, this report provides an assessment of the feasibility</p>		

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of using existing training devices for LAV training by developing sample training device options. It also provides recommendations on the use of evaluative factors which will be used both in the acquisition of training devices and in the evaluation of proposed training devices. Products of the Training Equipment Survey include:

- List of existing training devices which have potential application to LAV-25 training.
- Description of a training device which would provide training for turret operation/gunnery and operator maintenance.
- Potential training device options which could provide training for institution and unit training sites.
- Definition of preliminary training goals, requirements, constraints, and cost and non-cost criteria such that training device options can be evaluated and ranked.

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EXECUTIVE SUMMARY

In May 1983, the Naval Training Equipment Center (NTEC) contracted with Eagle Technology, Inc., to conduct a Training Device Requirements Analysis for the U.S. Marine Corps Light Armored Vehicle (LAV). The objective of this effort was to provide the Marine Corps with recommendations for a training device (or combination of training devices) to instruct LAV turret operation/gunnery skills and associated operator maintenance tasks.

This study was conducted in two phases. Phase I Task and Media Analysis results were used as a data base for Phase II, Training Equipment Survey. This report presents the procedures and results of Phase II. Since the anticipated acquisition strategy is "best value," this analysis and subsequent recommendations are structured to provide a frame of reference and data base for the anticipated performance specification associated with the solicitation. In effect, this means that the survey provides a hypothetical solicitation. It provides a frame of reference as to what type of training devices exist and are practical for modification and subsequent use in LAV training. The data base which results from this hypothetical solicitation resides in the data collected for the evaluative factors.

Thus, the findings, conclusions and recommendations provided in this report focus on the lessons learned from the hypothetical solicitation. The true value lies not in the options recommended since actual bids may or may not propose similar options. The value of this analysis lies in being able to assess the major factors which will contribute to a successful performance specification and subsequent evaluation of the responding proposals.

A total of five ITS and three unit training device options were developed. A training device option was defined as more than one training device which when used collectively will train all LAV hands on training tasks. These options were evaluated using 3 groups of evaluative factors: ITS/Unit training goals, ITS/Unit training environment constraints and trade-off criteria.

ITS/unit training goals document, in general terms, what the training at ITS and the unit is expected to accomplish. That is, what skills the graduate will be expected to perform after training.

ITS/unit training environment constraints are those factors in the training environment which might restrict the use of training devices due to lack of proper support resources. This includes resources such as personnel, facilities and equipment.

Finally, the third group of factors were combined under the heading of trade-off criteria. These factors include such factors as cost, fidelity, reliability and user acceptance.

Based on the study it is reasonable to conclude that training device options can be developed by modifying existing training devices. These training device options will be able to provide the training required to accomplish both institution and unit training goals, yet will function within the environment constraints at each site. Critical to both the specification and the evaluation of these options is concise specification of the evaluative factors. Recommendations for refinement and use of each of the evaluative factors is provided in the body of the report. The quality of the options which industry will propose will be a direct result of the specificity of performance specification provided by the Government.

ACKNOWLEDGEMENTS

This Training Equipment Survey Report, sponsored by the Commandant of the Marine Corps (CMC), was conducted under contract to the Naval Training Equipment Center (NTEC), Orlando, Florida.

The authors wish to thank Lt. Col. A. W. Powell, Training Review Office, LAV Acquisition Coordination Group, Code TD6-40, HQ USMC, as well as Dr. David J. Daly and Dick Glennon, Training System Analysis and Design Division, NTEC, who provided guidance and direction during the conduct of the study. In addition we wish to acknowledge the invaluable assistance and expertise provided by the subject matter experts and Command representatives who are cited in this report, from Headquarters, U.S. Marine Corps, Washington, D.C.; Marine Corps Air Ground Combat Center, Twentynine Palms, CA; Infantry Training School, Camp Pendleton, CA; The U.S. Army Infantry School, Fort Benning, GA, and Camp Lejeune, NC.

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SECTION I

INTRODUCTION

1.1 Background

In May 1983, the Naval Training Equipment Center (NTEC) contracted with Eagle Technology, Inc., to conduct a Training Device Requirements Analysis for the U.S. Marine Corps Light Armored Vehicle (LAV). The objective of this effort was to provide the Marine Corps with recommendations for a training device (or combination of training devices) to instruct LAV turret operation/gunnery skills and associated operator maintenance tasks. This study was designed to be carried out in two phases; the first, a Task and Media Analysis; and the second, a Training Equipment Survey. The Task and Media Analysis began with the documentation and analysis of all tasks required to operate the LAV-25 turret and perform associated gunnery and operator maintenance. Then, by applying a filtering process, tasks which required hands-on training (HOT) were determined. The fidelity requirements of these HOT tasks were then analyzed to derive training media alternatives. The results of the first phase, were documented in Light Armored Vehicle (LAV), Task and Media Analysis for the U.S. Marine Corps LAV-25 submitted in August of 1983 to Land Analysis and Design Branch (N-253), NTEC, Orlando, Florida.

Phase I Task and Media Analysis results were used as a data base for Phase II, Training Equipment Survey. This report presents the procedures and results of Phase II.

1.2 Scope

The Training Equipment Survey was designed to make recommendations about training devices for LAV turret operation/operator maintenance and associated gunnery skills. Since the anticipated acquisition strategy is "best value," this analysis and subsequent recommendations are structured to provide a frame of reference and data base for the anticipated performance specification associated with the solicitation. In effect, this means that the survey provides a hypothetical solicitation. It provides a frame of

reference as to what type training devices exist and are practical for modification and subsequent use in LAV training. This includes a cost estimate to determine if training device options which might be applicable to LAV training can be procured within a specified ceiling. It also provides a frame of reference as to which combinations of training device options would provide integrated training for both Infantry Training School (ITS) and the unit. The data base which results from this hypothetical solicitation resides in the data collected for the evaluative factors. This data can be used in the LAV training device procurement as either data to be provided to the bidders or as actual evaluative factors to rank the proposals.

Thus, the findings, conclusions and recommendations provided throughout this report focus on the lessons learned from the hypothetical solicitation. Since bidders may or may not propose options similar to those developed in the study, the value of this analysis lies in its contribution to a successful performance specification and the subsequent evaluation of responding proposals.

Products of the Training Equipment Survey include:

- List of existing training devices which have potential application to LAV-25 training.
- Description of a training device which would provide training for turret operation/gunnery and operator maintenance.
- Potential training device options which could provide training for institution and unit training sites.
- Definition of preliminary training goals, requirements, constraints, and cost and non-cost criteria such that potential training device options can be evaluated and ranked.

1.3 Report Organization

This report is organized into four sections. Section I presents background of the total LAV program, the purpose and scope of the Training Equipment Survey, and an overview of the approach taken. Section II describes the methodology for the Training Equipment Survey. Section III addresses the development of training device options and, finally, Section IV presents analysis results, findings, conclusions and recommendations. Appendices are provided with amplifying information considered too voluminous for inclusion in the report body.

1.4 Approach

The LAV Training Equipment Survey was completed using a five-step process which generally conformed to the guidelines of the Interservice Procedures for Instructional Systems Development (IPISD) (see Figure 1-1). The steps were:

- Identify existing training devices which might provide LAV training.
- Select existing training devices which will serve as representative of specific training types.
- Determine LAV training device options.
- Develop evaluative factors.
- Apply evaluative factors to training device options.

An overview of the methodology employed in completing these steps is presented in Section II.

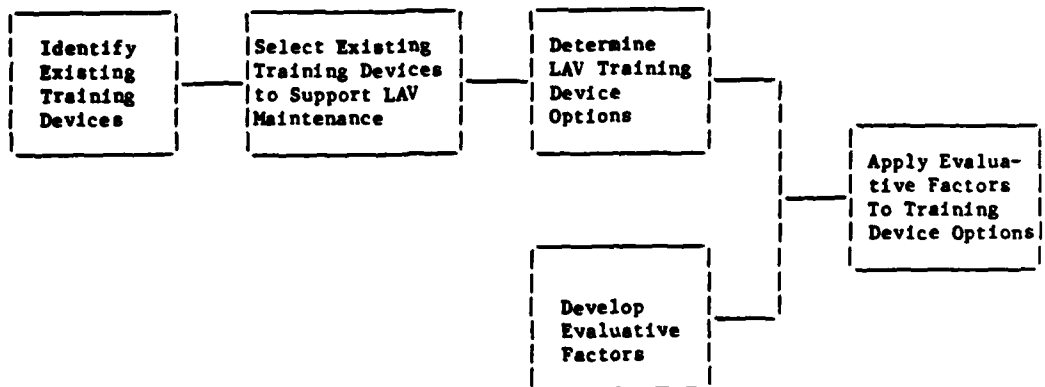


Figure 1-1. LAV Training Equipment Survey - Major Steps.

SECTION II METHODOLOGY

2.1 Process

Section II delineates the approach and methodology employed in conducting the LAV Training Equipment Survey. As noted in Section I, this involved completing the following steps:

- Identify existing training devices
- Select existing training devices to support LAV training
- Determine LAV training device options
- Develop evaluative factors
- Apply evaluative factors to training device options

Substeps for each of these steps is shown in Figure 2-1.

As discussed in the introduction, the value of this analysis is that it allows for a hypothetical solicitation to be examined. Figure 2-1 provides a graphic display of the activities which are involved in such a solicitation. Boxes 1-3 are activities which would, in an actual acquisition process, be accomplished by prospective bidders. Based on the capabilities of bidder devices and on the information in boxes 4.1 and 4.2, bidders would determine training device options to train the tasks which comprise the LAV HOT task categories. Government representatives would then evaluate the proposed training device options, box 5, using all of the evaluative factors.

In the remainder of this section, each of these steps and substeps is discussed to include all data sources and underlying assumptions.

2.2 Identify Existing Training Devices

The objective of this step in the LAV Training Device Analysis was to identify and describe existing training devices that could support the training of LAV HOT tasks which were categorized in the Phase I Task and Media Analysis. A summary of student actions comprising each category is presented in Appendix A.

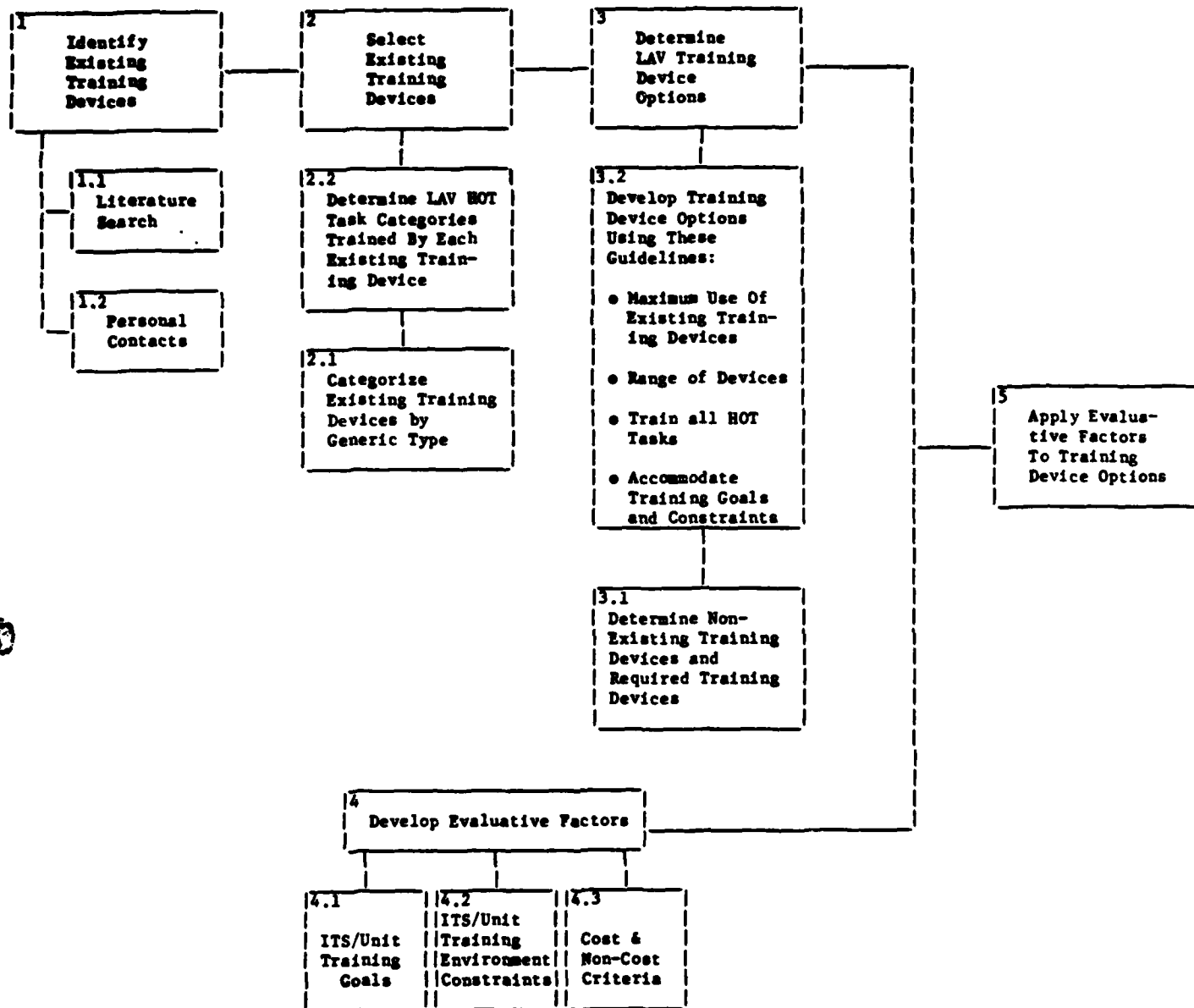


Figure 2-1. Training Equipment Survey - Steps and Substeps.

Training devices with potential for LAV training were identified from two sources: (1) literature search, and (2) personal contacts. Training devices commercially manufactured were identified via private corporations contacting Eagle Technology, or through personal contacts with manufacturers initiated by E-Tech.

2.2.1 Literature Search. The literature search conducted in Phase I was extended to a search of other source material and incorporated into the current training device survey (Phase II). The purpose of this literature search was to identify existing training devices that, with modification, could be made applicable to LAV training requirements, and to review training effectiveness studies on devices applicable to LAV-type training. Primary data sources were:

- Government Publications
- Manpower and Training Information System (MATRIS), Work Unit Search
- Defense Technical Information Center (DTIC), Work Unit Search
- DTIC Technical Report Search

For a detailed account of the literature search conduct, see Appendix B.

2.2.2 Personal Contacts. Concurrent with the literature review, information about potentially relevant devices was obtained through personal contacts. Information was gathered from:

- Government sources with knowledge about a particular training device or group of training devices. Primary locations of these sources were:
 - HQ, USMC Washington DC
 - USMC Liaison Office (Ground), NTEC Orlando, FL
 - Infantry Training School (ITS), Camp Pendleton, CA
 - USA Infantry School, Ft. Benning, GA
 - ARI Field Unit, Ft. Benning, GA
 - Naval Training Equipment Center, Orlando, FL
 - PM TRADE, Orlando, FL

- Contractors who design, develop, and fabricate training devices for armored vehicles.

- Educational Computer Corporation, Orlando, Florida
- Elbit Computers, Ltd., Advanced Technology Center, Haifa, Israel
- Fowler Associates, Inc., Santa Ana, California
- General Dynamics, Warren, Michigan
- General Electric Company, Simulation and Control Systems Department, Daytona Beach, Florida
- General Motors Diesel Division, London, Ontario, Canada
- Giravions Dorand Industries, Suresnes, France
- Honeywell Sondertechnik, Germany
- Perceptronics, Inc., Woodland Hills, California
- SAAB Scania Training Systems, Huskuarna, Sweden
- Sanders Associates, Inc., Nashua, New Hampshire
- Sperry Corporation, Great Neck, New York
- The Singer Company (UK) LTD, Lansing, Sussex

- Training device conventions and demonstrations.

- AUSA Annual Convention, Washington, DC
- 5th Interservice/Industry Training Equipment Conference, Washington, DC
- LAV Demonstration, Owen Sound, Canada
- Training Device Demonstrations (7)

Having identified potentially relevant training devices, detailed information about each device was obtained. In some instances, descriptive information was derived from DTIC technical reports. In other cases, product information was obtained directly from training device manufacturers. Some contractors involved in developing armored vehicle-type training devices contacted E-Tech analysts directly and provided the required product information in the form of briefings, product brochures, summary technical reports, and demonstrations.

2.3 Select Existing Training Devices

Once potentially relevant training devices were identified, it was necessary to determine which training devices had potential to train the established HOT task categories. To facilitate this process, devices were categorized generically and a determination made as to task categories that might be trained by the use of specific devices. These procedures are discussed in succeeding paragraphs.

2.3.1 Categorize Existing Training Devices by Generic Type. Based on data gathered during the Task and Media Analysis, it was determined that in order to clarify differences among training devices, they should be categorized by generic type. Generic categories were determined according to media attributes and capabilities. Appendix C lists specific criteria considered when placing a device in a generic category. The categories are:

- Actual Equipment with Substitute Firing Device
- Dynamic Model
- 2D/3D Panel Trainer
- Procedures Trainer
- 3D Mock-up

Training devices that did not fit into one of these categories were placed in a separate category labeled "Other."

2.3.2 Determine LAV HOT Task Categories Trained by Training Device. Having identified training devices with media attributes and capabilities that would support the instruction of LAV HOT tasks, the next step in the analysis process was to determine for each HOT task category the specific devices that could reasonably be expected to support LAV instruction. Training devices previously identified were evaluated on their potential applicability to train HOT tasks using the LAV task list as the standard of comparison. Data was gathered concerning each training device from available literature, observation of and participation with the training device, and conversations with individuals having expertise with the device. To facilitate the

evaluation, HOT task categories were grouped into two major categories, Gunnery Skills and Turret Operation/Operator Maintenance.

To determine which devices were most applicable to the HOT task categories, an examination was conducted of the way the device was typically used during instruction, including the level of training and the type of vehicle/equipment involved in this training. For each HOT task category, each associated training device was reviewed with respect to the HOT tasks comprising the category. A device was rejected as a candidate for supporting LAV training in this category if:

- The device did not have the capability of supporting the instruction of more than 50 percent of the tasks comprising a HOT task category.
- The device did not provide the level of media attributes needed for stimulus presentation, response acceptance, or feedback during performance of the tasks comprising a HOT task category.

Thus, the identification of candidate LAV training devices was accomplished through a process of classification and exclusion. That is, devices determined to have some potential for supporting LAV training were first classified in terms of the type of training they might support. Only those devices that provided maximum task coverage and at least the minimum required physical and functional fidelity were retained for further analysis. The product of this analysis step, therefore, comprised just those training devices that could reasonably be expected to support the instruction of LAV HOT tasks within each HOT category.

2.4 Determine LAV Training Device Options

The purpose of developing training device options was to provide the Government with a range of possible training device combinations for comparison purposes. Since no one training device can train all LAV HOT tasks, the term training device option refers to a specified combination of devices which, when used in the training environment, will provide for training of all LAV HOT tasks. Training device options were determined for

entry training at Camp Pendleton as well as for the sustainment and enhancement of skills in operational units. Training devices included in each option were from the pool developed as discussed in paragraph 2.3. Thus, all options meet required training capability as defined in the Task and Media Analysis.

To develop an option, it was necessary to determine if one or more training devices existed for the training of HOT task categories. If for a specific subset of HOT tasks no potential training device existed, then a generic training device type was specified based on the generic training device descriptions developed during the Task and Media Analysis. From this process, options were determined which would provide the requisite range of combinations for comparison.

Two substeps are involved in this process and are discussed in more detail in the remainder of this section.

2.4.1 Identify Non-Existing Training Devices. The first step in determining LAV training device options was to ascertain if one or more training devices exist for training of HOT tasks. If for one of the HOT task categories no training device existed, then a generic training device type was specified based on the generic training devices discussed in Section 2.3.1.

In conducting such an analysis, at least four outcomes are possible:

- 1) No existing training device.
- 2) Existing training device with more than needed capability.
- 3) Existing training device with less than needed capability.
- 4) Existing training device with required minimum capability.

Table 2.1 summarizes the range of alternative actions available depending on the analysis outcome. For example, if no training device existed to train all or part of a HOT task category, the available alternatives are to train with the actual equipment or develop a new training device that can train the HOT tasks. In contrast, if a training device exists with greater or less than required capability to train a HOT task category, the alternatives are to procure/modify the training device as well as train with actual equipment or develop a new training device.

TABLE 2.1. SUMMARY OF POSSIBLE LAV TRAINING DEVICE ALTERNATIVES

ANALYSIS OUTCOME	ALTERNATIVE ACTIONS			
	Train with Actual Equipment	Procure/Modify Training Device	Procure Training Device	Develop New Device Based on Media Analysis
No Existing Training Device	X			X
Existing Training Device With More Than Needed Capability	X	X		X
Existing Training Device With Less Than Needed Capability	X	X		X
Existing Training Device With Required Minimum Capability	X		X	

2.4.2 Develop Training Device Options. A requirement of Phase II, Training Equipment Survey, was to specify training device options that train all HOT tasks identified during Phase I, Task and Media Analysis. Using the pool of existing training devices identified and the training device alternatives identified above, training device options were specified using the following guidelines:

- Maximum use of existing devices.
- Range of devices from high fidelity/high cost to low fidelity/low cost.
- All HOT tasks trained.

- Accommodate training goals and training environment constraints.

2.5 Determine Evaluative Factors

Evaluative factors used to select and rank the training device options were grouped into three categories as follows:

- ITS/Unit Training Goals
- Training Environment Constraints
- Trade-Off Criteria

Factors within each category were used to eliminate options which could not accommodate training environment constraints and to rank the remaining options to determine the degree to which each option fits the training situation. Categories are defined in more detail in the remainder of this section.

2.5.1 ITS/Unit Training Goals. Institutional and unit training goals define the objectives of LAV training. As such they form the foundation for all subsequent evaluative factors, since ultimately training devices must contribute to the accomplishment of the training objectives. In the definition of training goals, both the entry level skills and the desired exit level skills were specified so that the training gap between "what is" and "what should be" could be clearly delineated. ITS and unit training goals obtained from Marine Corps documentation and personal contacts are presented in Section IV.

2.5.2 Training Environment Constraints. Within any training situation there are physical constraints. LAV training must be accomplished at a total of five training sites, the ITS and four unit locations. Each of these sites has specific personnel, facilities and equipment constraints which were identified as having potential impact on selection and ranking of training device options. The potential impact of these constraints is discussed in the remainder of this section.

2.5.2.1 Personnel. In scheduling the use of a training device, it is critical to know how many trainees are to be trained, the time available to train that given number, and the number of instructors available. The number of trainees will determine the number of training devices needed, which in turn may be reduced or increased depending on the time available to train. The instructor to trainee ratio can impact the amount of instructional support required as part of a training device. If there is a high instructor to trainee ratio, the training device may require less instructional support.

Instructional support in this context refers to the training device capability to provide trainee support and instructor support. Trainee support on the device would include feedback and guidance not inherent in the actual equipment. Instructor support features on a training device assist the instructor in monitoring, tracking and testing trainees. The level of instructional support required on a training device is usually a function of the trainee/instructor ratio. If instructors are available continuously to provide guidance and feedback while the trainee is learning and practicing on a training device, then the level of instructional support to be provided by the training device can be minimal. If, however, trainees use the device with minimal instructor assistance, then the sophistication of the instructional support should be maximized to enhance student learning and provide instructor assistance in the form of student monitoring, tracking and testing.

2.5.2.2 Facilities. Since some of the training devices evaluated require the use of ranges, access to both live fire and reduced scaled ranges was determined. Some of the training devices evaluated require classroom space, electrical power and climate control. The availability of these resources were specified by site based on available documentation and personal contacts.

2.5.2.3 Equipment. Two factors were cited within this constraint category; the quantity of LAVs per site, and annual ammunition training allowances.

Actual equipment was considered as a training device to be evaluated with the other proposed training devices. Therefore, the quantity available

becomes important. Moreover, some training devices evaluated are strapped to the LAV-25 for use. Thus, the number of LAVs available at each training site was determined.

Annual ammunition training allowances were documented so that the potential for gunnery practice using actual equipment could be determined. Access to the LAV without ammunition would limit the training of gunnery skills and necessitate use of a training device to simulate the gunnery environment.

2.5.3 Trade-Off Criteria. Trade-off criteria include both cost and non-cost factors selected as critical aspects of a training device that would directly influence its suitability for training. The most desirable situation would be to select a training option which would provide at the lowest cost possible, training devices which have high fidelity, reliability, and user acceptance, yet minimize maintainability, update (modifiability), new engineering design work, and technological development. Since no training option or device will provide the ideal, these factors were used to select and rank options relative to each other. The remainder of this section discusses each criteria.

2.5.3.1 Cost Criteria. Cost estimates were performed on selected devices for comparison purposes. Training devices were divided into three broad categories for the purpose of this estimate; actual equipment, existing training devices, and non-existing training devices. The criteria used in each of these categories is addressed in the following paragraphs.

2.5.3.1.1 Actual Equipment. Actual equipment was considered as part of the evaluation and is integral to all training device options. Since actual equipment will be available at all sites, the cost of the LAV was not considered a limiting factor. However, the cost of operating a LAV was considered and that data determined.

2.5.3.1.2 Existing Training Devices. Generic training device groupings were established which include all known types of trainers suitable for training mission oriented LAV turret tasks. Existing training devices

considered adaptable, with modification, to LAV training were evaluated and cost data obtained from manufacturer representatives. The devices were assigned to the appropriate category, and the highest cost quotation in each group was used in the comparison.

2.5.3.1.3 Non-Existing Training Devices. A training device capable of training mission oriented LAV turret operation/operator maintenance tasks was envisioned as a 3D mock-up device. The costs of a 3D mock-up were broken down into three basic areas: development costs, production costs, and operating/support costs. Estimates for each cost category were derived from material and labor estimates. Cost criteria rationale and assumptions used as a basis for cost estimates of the 3D mock-up are provided in Appendix D. Operating/support costs for a 3D mock-up were considered in relation to the operating/support costs of existing training devices.

2.5.3.2 Fidelity. Fidelity in most research has been consistently cited as an important factor in transfer of training. For this analysis, the definition developed by Hays (1980) will be used. In his study, fidelity is defined as "the degree of similarity between the simulator and the equipment which is simulated." It is a measurement of the physical characteristics of the simulator (physical fidelity) and the informational or stimulus and response capabilities of the equipment (functional fidelity). Thus, a given alternative is evaluated to determine not only if it looks or feels like the actual equipment, but also if it provides the trainee with the same type information provided by the actual equipment.

Analysis of the specific fidelity requirements for LAV training revealed different minimum fidelity needs for the HOT tasks in turret operation and operator maintenance than for the HOT tasks dealing with gunnery training. For the turret operation and operator maintenance tasks, the trainee will be practicing procedures which require equipment parts to "look" like the actual equipment (high physical fidelity) and to act like the actual equipment (high functional equipment).

The practice of gunnery skills involves not only fidelity factors related to functional and physical fidelity of the equipment, but visual

fidelity requirements as well. To practice gunnery tasks, the equipment on a training device must have that degree of physical and functional fidelity the trainee needs to get the "feel" of laying the gun and to practice the coordination skills necessary to fire on a target without "thinking" about the procedures step-by-step. Visuals are required which present not only the full range of combat environments but gunnery cues as well. Target fidelity requirements were based on an analysis of gunnery tasks within the HOT task listing. Training devices were ranked high, medium or low, depending on their ability to provide visuals approximating the actual environment.

2.5.3.3 Reliability and Maintainability. Normally, reliability refers to the average time that the system can function satisfactorily between unscheduled maintenance repair actions. This time, referred to as the mean time between failure (MTBF), determines the amount of time that will be available for meaningful student training without unscheduled and prolonged interruption.

Maintainability refers to the average time that is required after detection of a training device failure to restore the device to an operating status. This time, the mean time to repair (MTTR), is a function of the number of components, the fault isolation process, the degree of automated system tests (both built-in [BIT] and external) available, and the ease of replacement of failed components. The more complex the equipment is, the more time it usually takes to repair, and the more dependent it becomes on a highly skilled technician to perform that repair.

These factors were applied in particular to the evaluation of the 3D mock-up, but only in a general sense to existing training devices and actual equipment. Reliability and maintainability were evaluated by a relative comparison of the 3D mock-up, existing devices, and actual equipment, based on general assumptions, such as the complexity of the devices being evaluated and experience with other devices with comparable features.

2.5.3.4 Update/Modifiability. Since the LAV-25 is an emerging system for which certain hardware component have not yet been selected, the ability of each training system alternative to accommodate changes in hardware and

software is critical. Inherent in the ability to update hardware and software on the training device is the timeliness associated with making the required changes with minimum impact on the training environment that is representative of the operational environment. The system design must anticipate the need for upgrade and incorporate the flexibility to allow modification with minimum impact in both cost and time.

2.5.3.5 New Engineering Design Risk. The amount of new engineering design required in the development of a training device normally depends on whether an existing device is to be modified or a new device is to be developed and produced. Device complexity is also a major factor. The risk of new engineering design requirements is a measure of the impact that the lack of a proven or existing design and the required additional test, evaluation, and refinement of a new design will have on development, production start up, and ultimately, training device delivery date.

2.5.3.6 Technological Development Risk. Technological development risk refers to a design that utilizes a technology that has not yet been fully demonstrated (e.g., high resolution color flat panel display technology). If a training device requires the development of new or unproven technology, there is a high risk in that the technology itself must be developed before a commitment can be made to a design. If the technology development proves unsuccessful, then little or nothing is salvagable for the system design with the resultant severe impact to the training device development cost and schedule.

2.5.3.7 User Acceptance. User in this context refers to training developers, instructors and trainees. User acceptance is considered a critical factor since it frequently determines if the device is actually used at the training site. Personnel responsible for training programs who have unfavorable attitudes toward a particular training device tend to prescribe use of that device for a smaller and less significant portion of the total training program than may be possible. Additionally, instructors and trainees who hold a low opinion of the device training value, when given the option, tend to avoid its use regardless of the actual training value. The "look" of the training device may influence user perception. Training devices which

"look" like the actual equipment are often perceived as having more training potential while devices that appear simple and are constructed with inexpensive materials may have to "prove" their value. Therefore, the device must be designed so that it will be accepted and used by training personnel to its fullest potential.

"Ease of use" also impacts user acceptance. If the device is difficult and/or time consuming for the trainer to set up for use, then its use may be restricted. If the device is difficult to use, the trainee will avoid its use. Instances have been cited by trainers where trainees intentionally damaged training devices which were considered frustrating to use.

2.5.3.8 Instructional Support. Instructional support refers to those training device features which provide the student with feedback and guidance during the learning process. It also refers to those training device features which assist the instructor in monitoring, tracking and testing students. These features are not usually included in actual equipment except in those cases where the actual equipment has embedded training features. Types of student instructional support include:

- Visual aids to depict procedures or location of critical parts.
- A video-type prompter which is used to provide guidance and prompting to the student as he works on a learning sequence.
- Performance feedback to the student via a CRT.
- Visual or audio safety warnings to notify students of safety violations.

Examples of instructor instructional support include assistance in record keeping, student monitoring and fault insertion and testing. Training devices can be designed to provide this type of support so that instructors have more time to help students.

2.6 Application of Evaluative Factors to Training Device Options

Based on the trade-off criteria discussed above, a systematic order of application was developed. Since cost was specified as a "not to exceed amount," the first step was to determine the number of training devices required based on the following factors:

- Required student throughput.
- Training time available.
- ITS/unit training goals.
- ITS/unit training constraints.

Once the required number of devices was determined, the cost for each option was computed and those options exceeding the cost limit were eliminated from further consideration. All remaining training device options were ranked high, medium or low on each trade-off criterion.

SECTION III

TRAINING DEVICE OPTION DEVELOPMENT

3.1 Overview

Since no one trainer exists which can train all identified LAV HOT tasks, training device options were developed to provide the Government a frame of reference in the survey of existing training devices applicable for LAV turret operation/operator maintenance. For the purpose of this report, a training device option is defined as more than one training device which when used collectively will train all HOT LAV tasks.

Steps and substeps utilized in the development of training device options are shown in Figure 2-1. The results of these steps are discussed in the remainder of this section.

3.2 Identify Existing Training Devices

A total of 51 existing training devices with potential applicability to LAV HOT task categories were identified in the LAV Training Equipment Survey. These devices were identified as a result of a literature search and personal contacts in private industry. Appendix E lists the training devices identified.

3.2.1 Literature Search. A total of 149 documents were obtained and examined. These documents provided data concerning turret operation and gunnery skills on armored vehicle weapon systems, and contractor training materials and manuals. Appendix F provides a complete list of documents.

The literature search was successful in obtaining numerous training effectiveness studies on specific training devices. The majority of these studies were concerned with conduct of fire trainers and substitute firing devices. Appendix G lists studies on training devices with potential applicability to LAV.

The literature search further identified five documents that were instrumental in identifying training devices in the U.S. Government inventory. These documents are listed below:

- DA PAM 310-12, Index and Description of Army Training Devices
- FM 17-12-7, Survey of Tank Gunnery Devices
- Index to Directory of Naval Training Devices, Cognizance Symbol "20"
- Section 5, Directory of Naval Training Devices
- Catalog of War Games and Combat Simulations

The above documents were the sources of military hardware identified currently in the U.S. Government inventory with potential applicability to the LAV. A total of 27 devices were identified in this manner and are listed in Appendix E.

3.2.2 Personal Contacts. Information gathered from individual contacts with knowledge of armored vehicle type training devices was instrumental in insuring a comprehensive coverage of the subject. Personal contacts were utilized for clarification of data that could not be determined through available written documentation. For example, questions concerning user acceptability, reliability, etc., about armored vehicle type training devices currently in the field were often answered by individuals with personal experience in these areas.

Government sources were contacted when questions arose concerning a specific training device currently in the field or for clarification concerning ITS or unit training. The individuals listed below were especially helpful in E-Tech's data gathering process.

Powell, A. W.	LTC, USMC	Training Review Office LAV Acquisition Coordination Group	Headquarters U.S. Marine Corps (TDG-40) Washington, DC
Feigley, J. M.	Major, USMC	Asst. Marine Corps Liaison Office (Ground)	Naval Training Equipment Center Orlando, FL
Lytle, T. M.	Captain, USMC	OIC, LAV 25 Course	ITS Camp Pendleton, CA

Pearson, W. H.	Major, USMC	Commanding Officer	Company A First LAV Battalion MCAGCC Twentynine Palms, CA
Hobart, A. R.	MSG, USMC		Camp Lejeune, NC
Robertson, P.R.	SSG		U.S. Army Infantry School Ft. Benning, GA
Fagan, R. L.	Civilian		Naval Training Equipment Center Orlando, FL.

Personal contacts were also made with numerous contractors who design, develop, and fabricate training devices for armored vehicles. Through contacts with private industry, a total of 24 training devices were identified and are listed in Appendix E. Personal contacts with private corporations located the majority of dynamic models and procedures trainers, and 35% of the substitute firing training devices identified. Table 3.1 lists training devices considered applicable to LAV training requirements that were identified through contact with private industry.

Information that could not be obtained from written documentation or through personal contacts was gathered by attending training device conventions and demonstrations. Through these channels, opportunities were made to observe a wide variety of existing training devices.

E-Tech analysts also attended several lectures/demonstrations that provided information on specific training devices being considered. The devices that were discussed/demonstrated are listed below.

- General Electric Conduct of Fire Trainer
- Link Miles Conduct of Fire Trainer
- SAAB Scania Gunnery Trainers
- Perceptronics MK60 Gunner Trainer
- Honeywell MK20 On Board Gunner Simulator
- Fowler Associates Spiritus II Micro Controlled Training System
- Giravions Dorand DX 150 Tank Simulator, DX 175 Tactical Training Simulator

**TABLE 3.1. APPLICABLE LAV TRAINING DEVICES IDENTIFIED
THROUGH CONTACT WITH PRIVATE INDUSTRY**

<u>Device</u>	<u>Contractor</u>
Tank Turret Organizational Maintenance Trainer	Educational Computer Corporation
TANGA Classroom Trainer	Elbit Computers, LTD
Direct Fire Weapons Trainer (COFT)	General Dynamics
Fire Control Combat Simulator	General Dynamics
Conduct of Fire Trainer	General Electric
Tactical Training Simulator	Giravions Dorand
Turret Firing Training Simulator	Giravions Dorand
Turret Firing Simulator	Giravions Dorand
DX 201 Procedures Trainer	Giravions Dorand
On Board Gunnery Simulator	Honeywell Sondertechnik
Conduct of Fire Trainer	Link Miles
Tank Gunner Trainer	Perceptronics, Inc.
SAAB BT 41	Saab Scania Training Systems
Combat Classroom Trainer	Sanders Associates, Inc.

3.3 Select Existing Training Devices

Selecting existing training devices with the greatest potential for LAV training involved a three-step process. The first step was to categorize existing training devices by generic type from the total pool of devices identified. The second step was to determine the LAV HOT task categories trained by existing devices. Finally, using established selection criteria the total pool of existing devices was reduced to only those devices with the greatest potential for LAV training. The results of this procedures are discussed in the sections that follow.

3.3.1 Categorize Existing Devices by Generic Type. Using data obtained from available sources and the criteria presented in Appendix C, each training device was placed in an appropriate generic category. A total of 14 devices did not fit into any of the generic categories and were categorized "other." Table 3.2 depicts the number of existing training devices and the number of training devices ultimately selected in each generic training device category.

TABLE 3.2. NUMERICAL BREAKDOWN OF TRAINING DEVICES BY GENERIC CATEGORIES

	A.E. WITH SUB F.D.	DYNAMIC MODEL	2D/3D PANEL	PROCEDURES TRAINER	3D MOCK-UP	OTHER	TOTAL
# of Training Devices Identified	17	10	0	7	3	14	51
# of Training Devices Selected	12	5	0	5	2	0	24

Once existing training devices were placed into generic training device categories, it was necessary to determine which devices were most applicable to LAV training requirements. This procedure was accomplished by applying the established selection criteria. A device was selected for inclusion in training device options if:

- The device was capable of supporting the instruction of more than 50 percent of the tasks comprising a HOT task category, and
- The device provided the level of fidelity needed for stimulus presentation, response acceptance, or feedback during performance of the tasks comprising a HOT task category.

In this manner 51 training devices were evaluated and 24 ultimately selected for inclusion in the training device options. A brief description of each device eliminated, including manufacturer and rationale for elimination is found in Appendix H. Those devices that were selected are listed by HOT task and generic training device category in Table 3.3. Appendix I contains a visual representation and a description of each selected training device. The

TABLE 3.3 TRAINING DEVICES SELECTED

NOT TASK CATEGORIES	ACTUAL EQUIPMENT WITH SUB FIRING DEVICES	DYNAMIC MODEL		3D	PROCEDURES TRAINERS	3D MOCKUP
MAINTENANCE ACTIONS		TURRET TRAINER • TTOMT • M30A1				<ul style="list-style-type: none"> • Motorized Sectionalized 50 Caliber, M2 Machine Gun • 3F85 M85 Machine Gun
AMMO HANDLING		TURRET TRAINER • TTOMT • M30A1				
IMMEDIATE ACTIONS		TURRET TRAINER • TTOMT • M30A1				<ul style="list-style-type: none"> • Motorized Sectionalized 50 Caliber, M2 Machine Gun • 3F85 M85 Machine Gun
GUNNERY SKILLS	<u>SUBCALIBER</u> <ul style="list-style-type: none"> • M16A1 Rifle and Brewster Device • 50 Caliber Machine Gun and Telfare • 7.62mm Subcaliber Gun <u>LASER</u> <ul style="list-style-type: none"> • M55 Brewster/Stout • Giravions Dorand (DX 175 Tactical Training Simulator, DX 150 Simulator, DX 156 Turret Firing Training Simulator) • SAAB (BT 41) <u>CSI</u> <ul style="list-style-type: none"> • Honeywell 		<u>COFT</u> <ul style="list-style-type: none"> • General Electric • General Dynamics • Linkmiles 		<u>TABLETOP</u> <ul style="list-style-type: none"> • Giravions Dorand (DX 201) • Perceptronics (Tank Gunnery Trainer) • Sanders ("Combat Classroom Trainer") • Tanga (Classroom Tank Gunnery Trainer) <u>REDUCED COFT</u> <ul style="list-style-type: none"> • General Dynamics (Fire Control Combat Simulator) 	
TURRET OPERATIONS		TURRET TRAINER • TTOMT • M30A1				
BONESIGHT ALIGNMENT		TURRET TRAINER • TTOMT • M30A1				

remainder of this section will discuss the training devices selected within the generic categories.

3.3.1.1 Actual Equipment with Substitute Firing Device. A total of 12 training devices within the generic category Actual Equipment with Substitute Firing Device were determined to have applicability to the LAV. These are strap-on devices that when used with actual equipment substitute for firing a weapon. All 12 devices were concerned with training gunnery skills.

Actual equipment with substitute firing devices are divided into three subgroups:

- Subcaliber devices
- Laser technology devices
- Computer synthesized imagery devices

Subcaliber devices are training devices that fire live ammunition of a lesser caliber yet approximate the main gun trajectory. Subcaliber devices selected were:

- M16A1 Rifle and Brewster/STOUT Device (5.56mm or .22cal)
- .50 Caliber Machine Gun and Telfare Device
- 7.62mm Subcaliber Gun

Laser-type devices provide laser beams which simulate firing of the main gun. These devices vary in accuracy and range. The M55 laser device, for example, is accurate to 10-12 meters, while laser devices such as the SAAB BT-41 have the same range and accuracy as the weapon simulated. Laser substitute firing devices are strapped to the actual equipment and do not impede normal gunnery procedures. Devices selected were:

- M55 Laser
- Giravions Dorand
 - DX 175 Tactical Training Simulator
 - DX 156 Turret Firing Training Simulator
 - DX 150 Simulator
- SAAB BT-41

Computer synthesized imagery (CSI) devices provide fictitious targets, tracer trajectory, impact flash, superimposed on the actual terrain panorama as viewed through the sighting system. This type of device is also strapped to the actual equipment. The CSI device selected as a sample device was the Honeywell MK 20 Onboard Gunnery Simulator.

3.3.1.2 Dynamic Model. Five dynamic models were considered applicable to the LAV; two turret trainers, and three conduct of fire trainers (COFT). The turret trainers were chosen because they provide a hardware configuration that could be adopted for LAV use. Turret trainers are configured much the same as the actual equipment and provide realistic training without risk of damage or excessive wear on the armored vehicle.

Conduct of Fire Trainers have high physical and functional fidelity, provide hands-on training without use of the actual equipment, and can be used continuously. COFTs also provide timely and accurate instructional support such as immediate printout of exercise results and video replay of the exercise. Unlike turret trainers which provide hardware to practice turret operation/operator maintenance tasks, the COFT is concerned with training gunnery skills.

Examples of the dynamic model training devices selected are:

- Turret Trainer
 - Trainer, Tank Gunnery 105mm - M30A1
 - Tank Turret Organizational Maintenance Trainer - Educational Computer Corp.
- COFT
 - Conduct of Fire Trainer - General Electric
 - Direct Weapons Fire Trainer - General Dynamics
 - Conduct of Fire Trainer - Link Miles

3.3.1.3 2D/3D Panel Trainers. Based upon the generic category selection criteria, no existing 2 dimensional or 3 dimensional panel trainers were identified.

3.3.1.4 Procedures Trainer. Seven procedures trainers were identified and five ultimately selected to be included in the training device options. Two separate categories of procedures trainers were determined: tabletop and reduced COFT. Both the tabletop trainers and the reduced COFT are applicable to gunnery skills only.

With varying degrees of realism, tabletop trainers present targets and terrain scenes which are viewed through the gunner's sight permitting practice of gunnery techniques such as lead and burst on target. Tabletop trainers that were selected are as follows:

- Giravions Dorand DX 201
- Perceptronics MK-60 Tank Gunnery Trainer
- Sanders "Combat Classroom Trainer"
- Tanga Classroom Tank Gunnery Trainer

General Dynamics Fire Control Combat Simulator is a reduced COFT and was selected as potentially applicable to LAV training requirements. This device is configured to simulate essential hardware components of the actual equipment and has a gunner and commander station. It can simulate vehicle stabilization, trajectory/superelevation and time of flight of the actual weapon, and provides multiple battlefield scenarios.

3.3.1.5 3D Mock-up. Two 3D mock-ups were selected that could be applicable to operator maintenance actions and immediate actions for the main gun or COAX machine gun.

Characteristics of 3D mock-ups are:

- Familiarization with weapon system without danger to actual equipment
- Color coded and oversized parts
- Cut-away sections to permit external viewing of internal gun functions

Two examples of 3D mock-ups selected are:

- Motorized Sectionalized Gun .50 caliber - DVC 23-03
- Device 3F85 Mock-up M85 Machine Gun

These devices were selected due to inherent training features that could be incorporated into a 3D mock-up of the LAV guns. As will be discussed in paragraph 3.4.1, a 3D mock-up of the LAV turret is foreseen to have removable 3D mock-ups of the M242 25 mm chaingun and 7.62 mm COAX machinegun. These mock-ups will employ some of the training features of the 3D mock-ups discussed above.

3.3.2 Determine LAV HOT Task Categories Trained by Each Existing Training Device. Training devices that were identified as having potential applicability to LAV training requirements were analyzed to determine which HOT task categories, if any, they were capable of training. The training device did not necessarily have to be directly applicable to the specific LAV HOT task category in order to be placed in one of the six categories. Of importance was that the device address similar types of skills using the required media attributes such that modification to the device would be minimized. For example, none of the Conduct of Fire Trainers (COFT) identified were directly applicable to the LAV HOT task categories. However, the same concepts and technology used to develop a COFT for an M60 Tank can be used to build a COFT for the LAV.

One finding of HOT task category analysis was that few of the training devices initially identified focused on turret operation/operator maintenance tasks. Rather, the majority of devices were concerned with training various gunnery skills. Table 3.4 depicts the number of training devices applicable to each HOT task category. The total number of training devices across HOT task categories is greater than the 51 identified because some training devices were applicable to more than one task category.

TABLE 3.4 NUMBER OF TRAINING DEVICES APPLICABLE TO HOT TASK CATEGORY

	HOT Task Categories						
	Gunnery Skills	Maint. Actions	Ammo Handling	Immediate Actions	Boresight Alignment	Turret Operation	Other
Number of Training Devices	29	3	3	2	2	3	17

3.4 Specify Training Device Options. Using the list of existing training devices which had potential for training LAV HOT tasks, training device options were specified. Each option was structured to contain devices that, when used collectively, would train all tasks within the LAV HOT Task categories for both the unit and ITS level. Existing training devices fell into one of two types: those that were concerned with gunnery skills and those that were concerned with turret operation/operator maintenance. Therefore, the training device options also reflect this organization.

3.4.1 Determine Non-Existing Training Devices. A training device gap exists when no training device(s) identified can meet the training requirements for a given LAV HOT task category. Furthermore, in the event that a training device requires the use of actual equipment (e.g., substitute firing device), or a training device is capable of training all tasks within a HOT task category, actual equipment is assumed to be available for training. As a result, no specific training device gap was identified. However, the use of actual equipment for training was kept as limited as possible so that training-device use could be exploited to the maximum.

All HOT tasks, with the exception of gunnery skills, could be trained by turret trainers. However, the type of turret trainers selected for inclusion in training device options presented a situation in which the capabilities of the training device exceeded those which were required. One turret trainer,

the M30A1 Tank Gunnery Trainer, accurately simulates the hardware components of the M60A1 tank turret, and the entire trainer possess a level of physical and functional fidelity not required for LAV training. This trainer is currently in the U.S. Government training device inventory but would require extensive modification.

A second trainer, the Tank Turret Organizational Maintenance Trainer (TTOMT), is a turret trainer that provides substantially greater capabilities than required for LAV training. This trainer is in the prototype stage of development and will enable trainees to become proficient in maintaining the M1 tank turret. The device is a three-dimensional rotating mock-up of the M1 turret, with hardware the same as the actual equipment. Malfunctions are inserted via computer interface from the instructor's station. Audio cues are provided that support malfunction symptoms. A computer monitors trainee progress for correct sequence of task actions and elapsed time, and provides the instructor a printed copy of the trainee's performance. The entire training device is surrounded by a viewing platform. LAV training needs do not require a device of such fidelity and its use would result in training overkill. While training overkill is not necessarily detrimental, it does significantly increase the cost of the device.

After reviewing existing turret trainers, E-Tech analysts determined that a 3D mock-up of the LAV turret would be a more cost effective alternative to train turret operation/operator maintenance tasks. Developing and producing a LAV turret trainer which includes only components and parts essential for training, minimizes costs while maintaining enough fidelity to train to established standards. An artist's concept of the 3D mock-up is shown in Figure 3.1.

The 3D mock-up is envisioned to be a non-enclosed mock-up of the LAV turret designed to train turret operation/operator maintenance tasks. Only enough fidelity to ensure training transfer will be built into the trainer. As identified in the Task and Media Analysis, fidelity of the physical relationship of components to each other and to the trainee will be high, whereas the functional fidelity of the turret and guns are low. Lights and indicators will function realistically in response to switch activation, but

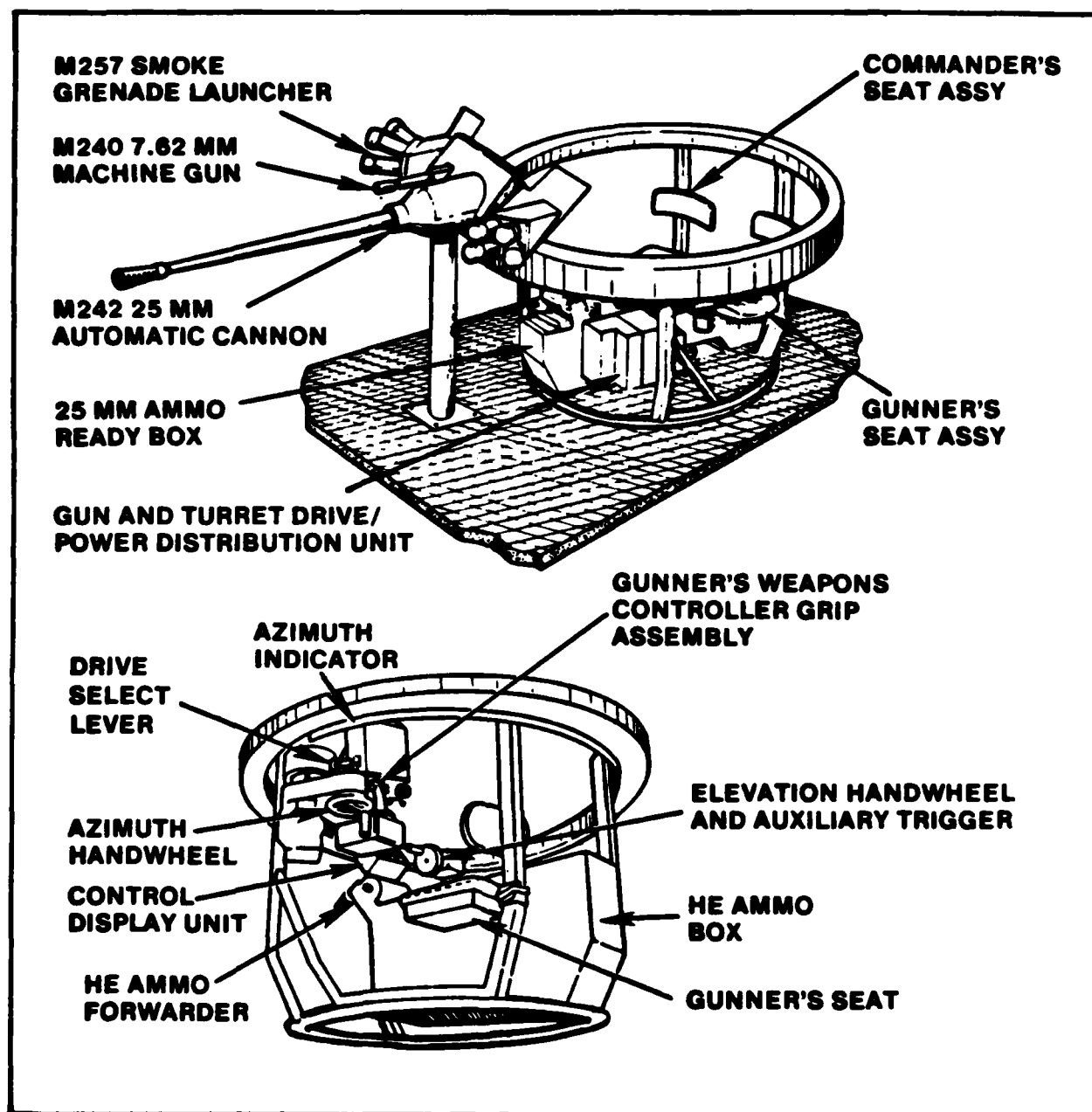


Figure 3.1. LAV 3-D Mock-Up (Conceptual Illustration)

no feedback from the device concerning sequence correctness will be provided. All functioning parts will be commercial off-the-shelf units. Wood could be used extensively in the device housing and certain of the non-functioning components. A complete description of the assumption on which the 3D mock-up is based is found in Appendix D.

Two 3D Mock-ups were identified that can train operator maintenance and immediate actions HOT tasks. These devices, like the procedures trainers, are not directly applicable to the LAV. However, the same principles employed in their design can be applied when developing a LAV 3D turret mock-up.

3.4.2 Training Device Options. Training device options were developed to maximize use of existing training devices and to provide a wide range of options in terms of cost and fidelity. Options were developed such that they accommodate ITS/Unit training goals and training constraints.

3.4.2.1 Training Device Options for Infantry Training School (ITS). A total of six options (A-F) were determined for ITS. Each option is capable of training all tasks in the HOT categories and differs only in the training devices selected for training gunnery skills. Devices selected for turret operation/operator maintenance tasks were the same for each option with the exception of Option F. Option F contains the Tank Turret Organizational Maintenance Trainer (TTOMT) training device discussed previously, while Options A-E contain the 3D mock-up of the LAV turret. Table 3.5 presents the options developed for ITS. From this table, it can be seen that procedures trainers are included in each option, with the exception of Option F. Procedures trainers were included for two reasons. First, entry skill level of recruits at ITS is relatively low. Therefore, an easy to use training device that teaches basic gunnery skills is required. Procedures trainers fulfill such a requirement. Secondly, due to the time constraints characteristic of ITS, flexibility in scheduling of training is needed. Procedures trainers again fulfill this need since they can be used virtually anytime, anywhere, and without supervision. Using procedures trainers as a benchmark, training devices were included that provided varied training opportunities and difficulty levels.

TABLE 3.5. TRAINING DEVICE OPTIONS (ITS)

LAV HOT TASK CATEGORIES	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION F
MAINTENANCE ACTIONS	3D MOCKUP	3D MOCKUP	3D MOCKUP	3D MOCKUP	3D MOCKUP	TURRET TRAINER
AMMO HANDLING						
IMMEDIATE ACTIONS						
TURRET OPERATIONS						
GUNNERY SKILLS	DYNAMIC MODEL (COFT) + PROCEDURES TRAINER (TABLETOP) + ACTUAL EQUIPMENT	PROCEDURES TRAINER (TABLETOP) + SUBSTITUTE FIRING DEVICE (VISUAL) + ACTUAL EQUIPMENT	PROCEDURES TRAINER (TABLETOP) + SUBCALIBER + ACTUAL EQUIPMENT	PROCEDURES TRAINER (TABLETOP) + LASER (M55) + ACTUAL EQUIPMENT	PROCEDURES TRAINER (TABLETOP) + ACTUAL EQUIPMENT	DYNAMIC MODEL (COFT) (CSI) + ACTUAL EQUIPMENT
BORESIGHT ALIGNMENT						

NOTE: Substitute firing devices, subcaliber devices and laser devices are strapped to the actual equipment.

Also included in each option is the actual equipment. Actual equipment was included because of the difficulty in performing boresighting alignment with a training device and because substitute firing devices and subcaliber devices must be strapped onto the LAV.

Table 3.6 presents a breakdown of HOT tasks trained by specific training devices within each option. Appendix J contains a complete list of validated LAV-25 tasks. Concerning turret operation/operator maintenance tasks, each option for ITS contains the 3D mock-up of the LAV turret with the exception of Option F. The 3D mock-up is envisioned to train all HOT turret operation/operator maintenance tasks identified in the task and media analysis. Option F contains a tank turret device that can train all turret operation/operator maintenance HOT tasks except for some removal and installation procedures. Actual equipment is added to train these tasks.

Concerning gunnery HOT tasks, Option A contains the COFT, which is capable of training all gunnery skills. Option B contains substitute firing devices with actual equipment. This type of training device is also capable of training all gunnery HOT task categories. Option C is comprised of subcaliber devices. Subcaliber training devices, when strapped to the actual equipment, can train all gunnery HOT tasks with the exception of stabilization operating procedures and zeroing. In this case, actual equipment is used. Option D contains the M55 laser firing device which, when strapped to the LAV, can be used to train daysight/nightsight procedures, LOS drift compensation procedures, engaging targets, and select and occupy firing position gunnery skills. Procedures trainers are capable of training the remaining gunnery skills. Option E contains only procedures trainers and the actual equipment. Actual equipment is needed to train the following gunnery skills: daysight/nightsight procedures, LOS drift compensation, zeroing, and select and occupy firing positions. Option F contains a COFT training device and a computer synthesized imagery gunnery trainer. Both of these devices train all HOT gunnery tasks. Boresighting alignment is trained by actual equipment in all options.

TABLE 3.6 HOT TASKS TRAINED BY TRAINING DEVICE OPTIONS - ITS

HOT TASKS	HOT TASKS AS ASSIGNED IN					OPTION C	OPTION D	OPTION E	OPTION F
	TASK AND MEDIA ANALYSIS	OPTION A	OPTION B	OPTION C	OPTION D				
TURRET OPERATIONS									
• Troubleshooting	11.1-11.3	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
• Turret Checklist	3.1-3.4, 4.1-4.4, 8.4-8.5	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
• Dry Fire Checklist	2.5	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
• Grenade Launcher	11.3, 2.4, 6.7, 7.10, 8.3	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
• Immediate Actions	7.1, 7.11, 7.12	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
MAINTENANCE ACTIONS									
• BAI	10.1-10.4	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	AE
• Preventive	9.1-9.15	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
• Troubleshooting	11.4-11.6	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
AMMO HANDLING									
	2.1-2.4, 8.1-8.2	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
IMMEDIATE ACTIONS									
	7.2-7.9	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trnr
GUNNERY SKILLS									
• Stabilization Operating Procedures	4.5	COFT, Proc. Trnr	Sub PD	AE, Proc. Trnr	AE, Proc. Trnr	AE, Proc. Trnr	Proc. Trnr	COFT, CSI	
• M36E1 Day/Night-sight Procedures	4.6, 4.8	COFT	Sub PD	Subcaliber	M55 Laser	M55 Laser	AE	COFT, CSI	
• LOS Drift	4.7	COFT	Sub PD	Subcaliber	M55 Laser	M55 Laser	AE	COFT, CSI	
• Zeroing	3.6	COFT	Sub PD	AE	M55 Laser	M55 Laser	AE	COFT, CSI	
• Firing Techniques	6.1-6.4	COFT, Proc. Trnr	Sub PD	Subcaliber, Proc. Trnr	Proc. Trnr	Proc. Trnr	Proc. Trnr	COFT, CSI	
• Engaging Targets	6.5-6.6	COFT, Proc. Trnr	Sub PD	Subcaliber, Proc. Trnr	M55 Laser, Proc. Trnr	M55 Laser, Proc. Trnr	Proc. Trnr	COFT, CSI	
• Target I.D.	5.4, 5.5	COFT, Proc. Trnr	Sub PD	Subcaliber, Proc. Trnr	Proc. Trnr	Proc. Trnr	Proc. Trnr	COFT, CSI	
• Firing Position	6.8	COFT	Sub PD	Subcaliber	M55 Laser	M55 Laser	AE	COFT, CSI	
BORESIGHT ALIGNMENT									
	3.5, 3.7	AE	AE	AE	AE	AE	AE	AE	AE

NOTE: Substitute firing devices, subcaliber devices and laser devices are strapped to actual equipment.

3.4.2.2 Training Device Options for Unit. Four training device options were determined for the unit. As with ITS, each option developed for the unit will train all HOT task categories. Unit training device options make maximum use of existing training devices and provide a wide selection range in terms of cost and fidelity. Devices selected for turret operation/operator maintenance tasks were the same for all but one option (Option D). Therefore, the only difference among Options A-C are the training devices selected for training gunnery skills. Table 3.7 presents the unit options.

TABLE 3.7. TRAINING DEVICE OPTIONS (UNIT)

HOT TASKS	OPTION A	OPTION B	OPTION C	OPTION D
MAINTENANCE ACTIONS	3D MOCK-UP	3D MOCK-UP	3D MOCK-UP	TURRET TRAINER
AMMO HANDLING				
IMMEDIATE ACTIONS				
TURRET OPERATIONS				
GUNNERY SKILLS	DYNAMIC MODEL (COFT) +	SUBSTITUTE FIRING DEVICE (VISUALS) +	SUBCALIBER +	DYNAMIC MODEL (COFT) +
BORESIGHT ALIGNMENT	SUBSTITUTE FIRING DEVICE (VISUALS) +	ACTUAL EQUIPMENT	ACTUAL EQUIPMENT	ACTUAL EQUIPMENT
	ACTUAL EQUIPMENT			

NOTE: Substitute firing devices and subcaliber devices are strapped to actual equipment.

The LAV turret 3D mock-up proposed for use at ITS for training turret operation/operator maintenance tasks is also proposed for use at the unit for Options A-C. The same turret trainer recommended in ITS Option F is also recommended for Option D at the unit.

Table 3.8 presents a breakdown of unit HOT tasks trained by specific training devices within each option. Regarding turret operation/operator maintenance tasks, just as at ITS, each HOT task identified in the task and media analysis will be trained by a 3D mock-up of the LAV turret for Options A-C. Also, as in ITS Option F, the turret trainer proposed in Option D will train all HOT tasks except sections of the removal and installation procedures for the weapons.

Referring to the ITS and Unit Option Tables, it can be seen that there are many similarities in training device options recommended for training gunnery skills. Options A-C for both the unit and ITS are similar except for the absence of procedures trainers at the unit. There were several reasons for not including procedures trainers at the unit. Based upon current data, the procedures trainer is designed to train entry level gunnery skills and is judged inappropriate for use since the trainee will have received this type of training at ITS. As a result, any benefit the unit trainee would receive from use of a procedures trainer would be minimal. Training at the unit level focuses on crew training. The procedures trainer is designed to train gunners and not crews. Installing procedures trainers at the unit level would place emphasis on individual training instead of crew training. The quantity of training devices required at ITS is more than twice as many as required at the unit. This significantly increases the cost of unit training device options. By eliminating procedures trainers from unit options, additional funds may be made available for the acquisition of other training devices.

Referring to Table 3.8, it can be seen that in Option A, all HOT tasks are trained by both the COFT and substitute firing device with actual equipment. Option B is the same as Option A, except that a COFT is not included. All HOT gunnery tasks are trained with the substitute firing

TABLE 3.8. HOT TASKS TRAINED BY TRAINING DEVICE OPTIONS - UNIT

HOT TASKS	HOT TASKS AS ASSIGNED IN TASK AND MEDIA ANALYSIS	OPTION A	OPTION B	OPTION C	OPTION D
TURRET OPERATIONS					
• Troubleshooting	11.1-11.3	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
• Turret Checklist	3.1-3.4, 4.1-4.4, 8.4-8.5	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
• Dry Fire Checklist	2.5	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
• Grenade Launcher	11.3, 2.4, 6.7, 7.10, 8.3	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
• Immediate Actions	7.1, 7.11, 7.12	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
MAINTENANCE ACTIONS					
• R&I	10.1-10.4	3D Mock-Up	3D Mock-Up	3D Mock-Up	AE
• Preventive	9.1-9.15	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
• Troubleshooting	11.4-11.6	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
AMMO HANDLING	2.1-2.4, 8.1-8.2	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
IMMEDIATE ACTIONS	7.2-7.9	3D Mock-Up	3D Mock-Up	3D Mock-Up	Turret Trainer
GUNNERY SKILLS					
• Stabilization Operating Procedures	4.5	COFT, Sub FD	Sub FD	AE	COFT, Sub FD
• M36E1 Day/Night-sight Procedures	4.6, 4.8	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
• LOS Drift	4.7	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
• Zeroing	3.6	COFT, Sub FD	Sub FD	AE	COFT, Sub FD
• Firing Techniques	6.1-6.4	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
• Engaging Targets	6.5-6.6	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
• Target I.D.	5.4, 5.5	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
• Firing Position	6.8	COFT, Sub FD	Sub FD	Subcaliber	COFT, Sub FD
BORESIGHT ALIGNMENT	3.5, 3.7	AE	AE	AE	AE

NOTE: Substitute firing devices and subcaliber devices are strapped to actual equipment.

device. In Option C, all gunnery tasks are trained using subcaliber devices except stabilization operating procedures and zeroing. In this situation, actual equipment is needed to train these tasks.

Option D has the identical training devices for gunnery skills as Option A. The only difference between the two options is the device recommended for turret operation/operator maintenance. Option D was comprised to illustrate the type of options possible at a higher funding level.

SECTION IV

ANALYSIS

4.1 General

This section discusses the evaluative factors in terms of the data collected to define these factors and the results of actually applying the factors to the training device options developed in Section III. As noted in the introduction, this data can be used in several ways. First, the factors, themselves, can be examined in terms of usefulness and completeness. For example, if, in the evaluation of training device options, a factor such a "new design risk" is found to be ineffective for use as an evaluative criteria, then this factor could be deleted for use in the review of bids on the LAV training device procurement. Second, the data collected to define these factors can be used in the LAV training device procurement as either data to be provided to the bidders or as actual evaluative factors to rank the proposals. The evaluative factors comprise three groups of related information: ITS/Unit Training Goals; ITS/Unit Training Environment Constraints; and Trade-Off Criteria.

ITS/unit training goals document, in general terms, what the training at ITS and the unit is expected to accomplish. That is, what skills the graduate will be expected to perform after training. ITS/unit training environment constraints are those factors in the training environment which might restrict the use of training devices due to lack of proper support resources. This includes resources such as personnel, facilities and equipment. Finally, the third group of factors was combined under the heading of trade-off criteria. These factors include such factors as cost, fidelity, reliability and user acceptance.

The remainder of this section will discuss the data collected for each evaluative factor, present the results of applying these factors to the training device options and, finally, discuss the use of each factor in the acquisition process.

4.2 ITS/Unit Training Goals

The LAV tasks to be trained at ITS and the unit are the same. The goals, however, differ in terms of focus and level of performance required. The focus of ITS is to train individual skills such that trainees are "combat ready." The focus of the unit training is to refine the individual skills of the ITS LAV graduate such that he acquires crew skills necessary for tactical employment of the LAV. Although training plans for both ITS and unit sites are in the development stage, the following data was available and was sufficient for guidance in evaluating training device options.

4.2.1 ITS Training Goals. Training at ITS focuses on individual skills to produce LAV crewmen who can perform turret operations, operator maintenance and gunnery tasks to establish standards. Most of the training time available for turret training will focus on the procedures involved in turret operation/operator maintenance since these procedural tasks provide the foundation for use of the vehicle. The trainee will receive gunnery training and be required to qualify to a minimal performance level using the vehicle and live ammunition.

A major objective of ITS is to provide as much training as possible during the six weeks available. Thus, utilization of all resources, including training devices, will be maximized. This will impact the number of devices required as well as the required reliability and maintainability.

All training device options developed would support attainment of ITS goals. The use of the 3D mock-up would insure that the trainee would have suitable hands-on time available for practice of turret operation and operator maintenance. The gunnery trainers proposed provide a wide range of training in terms of "state-of-the-art" technology and potential transfer of training. All have the potential to train the required tasks to the required level of performance. Training throughput constraints can be accommodated by providing sufficient numbers of the devices to insure that trainees do not wait to practice on the devices.

4.2.2 Unit Training Goals. Unit training goals are to sustain individual skills as well as to develop and enhance crew and platoon interactive skills in the tactical distribution of fire. Training device options addressed by this study include those applicable for crew training only. Platoon training is not within the scope of work performed.

Since the tasks associated with turret operation and operator maintenance are learned at ITS, the primary training focus of the unit will be on gunnery skills. As at ITS, firing tables using live ammunition will be used to qualify gunners but the required performance level will be elevated. All of the options proposed have the potential to provide the training required for attainment of unit training goals.

4.2.3 Comment. Since the training plans at both ITS and the unit are in the development stage, the level of performance to be accomplished at each site is not yet specified except in general terms. This information should be obtained and documented as the training plans are refined and implemented. Specification of the performance required after training, especially the level of performance of gunnery skills required, will have a direct impact on the nature of the training devices required. For example, a decision that minimal gunnery skills will be acquired at ITS will impact fidelity requirements of the gunnery trainer used at ITS as well as the number of trainers required. Thus, critical for the performance specification will be information which defines not only the tasks to be trained at ITS and the unit, but also the level of performance required by task as a result of training.

4.3 Training Environment Constraints

Characteristics of an environment and restrictions organic to that environment can have a direct affect on the type and number of training devices applicable to it. Three factors common to both ITS and the various units have been identified as potentially impacting upon ultimate selection of training device options. These areas are personnel, facilities, and equipment. Table 4.1 presents specific data unique to each site.

TABLE 4.1. TRAINING ENVIRONMENT CONSTRAINTS - ITS/UNIT

PERSONNEL	FACILITIES	EQUIPMENT
<ul style="list-style-type: none"> • QTY PERSONNEL TO BE TRAINED ANNUALLY • QTY OF TRAINING HOURS PER PERSON ANNUALLY • INSTRUCTOR TO TRAINEE RATIO 	<ul style="list-style-type: none"> • AVAILABILITY OF LIVE FIRE RANGES • AVAILABILITY OF REDUCED SCALE RANGES • CLASSROOM SPACE AVAILABILITY • AVAILABILITY OF ELECTRICAL POWER • CLIMATE CONTROL 	<ul style="list-style-type: none"> • QTY OF LAVs PER UNIT • ANNUAL AMMUNITION TRAINING ALLOWANCES

4.3.1 Personnel Factors. Three personnel factors were documented for training sites:

- Quantity of personnel to be trained annually.
- Quantity of training hours per trainee.
- Instructor to trainee ratio.

These factors are discussed, by site, in the remainder of this section.

4.3.1.1 Personnel Factors - ITS. Personnel factors for ITS are summarized below.

- Quantity of Personnel To Be Trained Annually
 - 240 Crewman Course
 - 80 Officer Course (Projected)
 - 320 Total (Projected)
- Quantity of Training Hours Per Trainee
 - 120 Hours Crewman Course
 - (TBD) Hours Officer Course

- Instructor/Trainee Ratio
 - 1/5 Crewman Course
 - 1/2 Officer Course (Projected)

4.3.1.2 Personnel Factors - Unit. The number of individuals to be trained annually at the unit level will vary with unit strength and personnel turnover. A total of 646 is projected. Tables 4.2 and 4.3 describe the training breakdown, the totals for each site, and the number of individuals expected to be trained at each site.

TABLE 4.2. ANNUAL UNIT TRAINING THROUGHPUT

LOCATION	TYPE OF TRAINING REQUIRED		TOTALS
	LAV-25 GUNNERS MOS 0313	SUPERVISORS OF GUNNERY OPS AND TRAINING MOS 0303, 0370, 0313	
CAMP LEJEUNE	50	92	142
MCAGCC TWENTYNINE PALMS	53	89	142
CAMP PENDLETON	35	65	100
CAMP BUTLER	17	29	46
TOTALS (NOTE 1)	155	275	430
TOTALS (NOTE 2)	233	413	646

NOTE 1: BASED ON STATIC SITUATION WHERE EACH PERSON HOLDS BILLET FOR ENTIRE YEAR.

NOTE 2: MORE REALISTIC; INCLUDES 50% ADJUSTMENT TO ACCOUNT FOR VARIOUS FORMS OF UNIT ATTRITION IN A YEAR.

TABLE 4.3. ESTIMATED LAV UNIT TRAINEE ANNUAL THROUGHPUT

TYPE OF TRAINING REQUIRED

CAMP PENDLETON		
LOCATION	LAV-25 GUNNERS MOS 0313	SUPERVISORS OF GUNNERY OPS AND TRAINING MOS 0303, 0370, 0313
H&S CO (-), 1ST LAV BN	0	4
WEAPONS CO (-), 1ST LAV BN	5	7
LAA COS (2), 1ST LAV BN	30	54
TOTALS (NOTE 1)	35	65
TOTALS (NOTE 2)	53	98

CAMP BUTLER, OKINAWA

LOCATION	LAV-25 GUNNERS MOS 0313	SUPERVISORS OF GUNNERY OPS AND TRAINING MOS 0303, 0370, 0313
CO D (REIN), 3RD LAV BN	15	27
REINFORCEMENTS	2	2
TOTALS (NOTE 1)	17	29
TOTALS (NOTE 2)	26	44

TYPE OF TRAINING REQUIRED

CAMP LEJEUNE		
UNIT	LAV-25 GUNNERS MOS 0313	SUPERVISORS OF GUNNERY OPS AND TRAINING MOS 0303, 0370, 0313
H&S CO, 2D LAV BN	0	4
WEAPONS CO, 2D LAV BN	5	7
LAA COS (3), 2D LAV BN	45	81
TOTALS (NOTE 1)	50	92
TOTALS (NOTE 2)	75	138

MCAGCC TWENTYNINE PALMS

LOCATION	LAV-25 GUNNERS MOS 0313	SUPERVISORS OF GUNNERY OPS AND TRAINING MOS 0303, 0370, 0313
CO/A (REIN), 1ST LAV BN	18	24
H&S CO (-), 3RD LAV BN	0	4
WEAPONS CO (-), 3RD LAV	5	7
LAA COS (3), 3RD LAV	30	54
TOTALS (NOTE 1)	53	89
TOTALS (NOTE 2)	80	134

NOTE 1: BASED ON STATIC SITUATION WHERE EACH PERSON HOLDS BILLET FOR ENTIRE YEAR.

NOTE 2: MORE REALISTIC; INCLUDES 50% ADJUSTMENT TO ACCOUNT FOR VARIOUS FORMS OF UNIT ATTRITION IN A YEAR.

Based upon available information, MOS 0313s will have 320 hours of training time available per year. This includes 8-10 hours of live firing with the remainder devoted to hands-on training using training devices and actual equipment. For MOS 0312s and LAV officers, the available training hours are 160 per year, four of which are devoted to live firing. See Figure 4.1 for a summary of training time available at the unit level.

The instructor/student ratio at the unit level is expected to be as follows:

- Platoon Training - two instructors (platoon commander and platoon sergeant) to 11 trainees (crews minus platoon commander).
- MOS 0312 Familiarization Training - one instructor to six trainees (primary instructor will be vehicle commander).

For the purposes of this study, the assumption was made that training would be accomplished at the platoon level, that is, a typical training group would be platoon size with the platoon commander and/or the sergeant supervising and the training scheduled so that all platoon members are in attendance. This is in contrast, for example, to one or two platoon members accomplishing training on an individual basis.

4.3.1.3 Comments - Application of Personnel Constraints - ITS/Unit.

The personnel factors discussed for ITS and the unit provide no reason for exclusion of any of the training device options. This data will be used to determine the number of training devices required and is discussed in paragraph 4.4.

All three personnel factors identified are critical for inclusion in the specification package and, in turn, should be used as evaluative factors when proposals are received. This data must be accurate since it is a major factor in determining the number of training devices required at each site. The number of training devices required to provide training may exclude some devices due to cost.

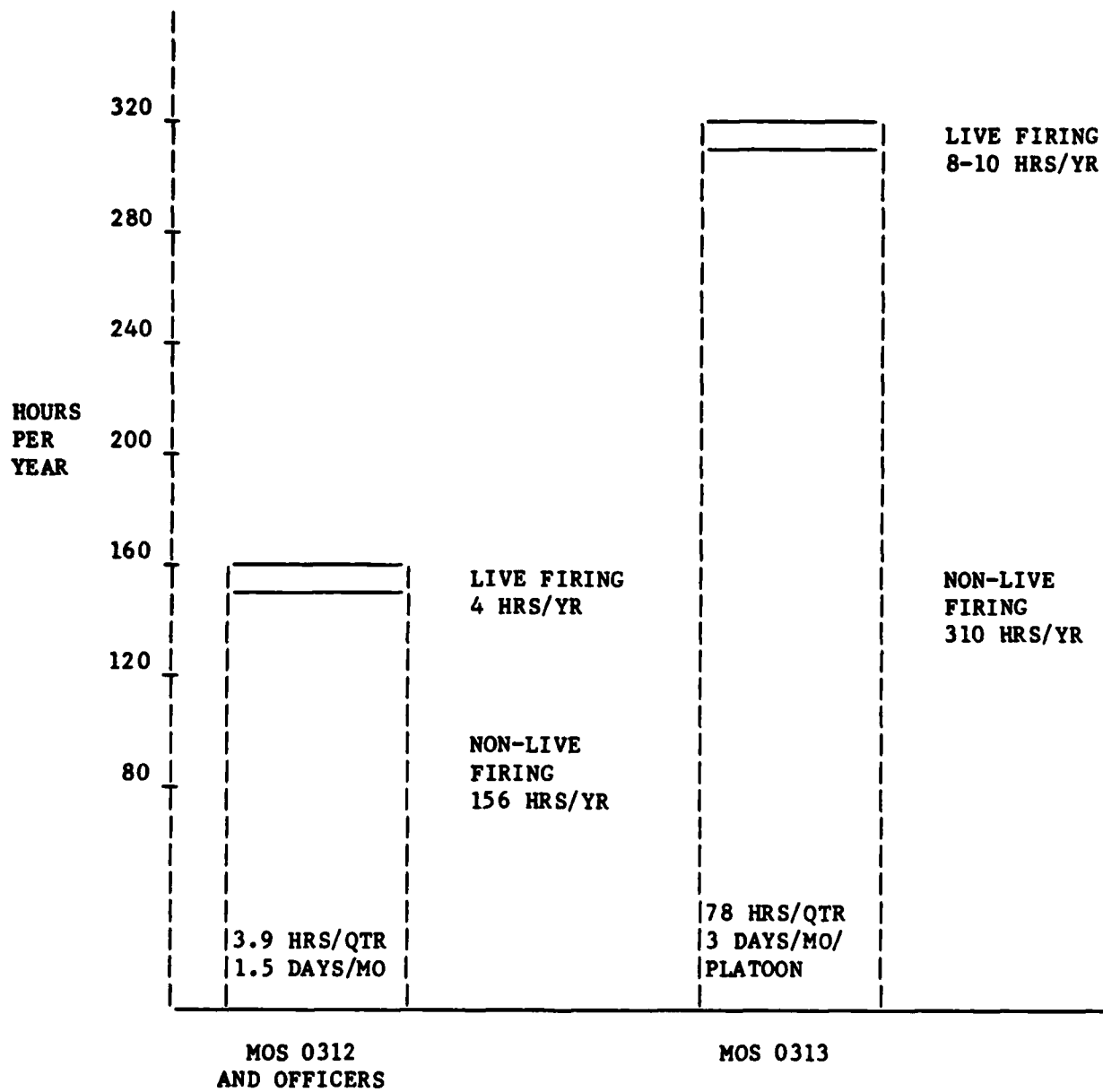


Figure 4.1. Unit Training Time Available.

4.3.2 Facilities Factors. Five separate factors were considered when evaluating the facilities at ITS and the unit sites. These factors were:

- Availability of live fire ranges
- Availability of reduced scale ranges
- Classroom space availability
- Availability of electrical power
- Climate control

The types of ranges available and their access for LAV training will directly impact the practicality of employing subcaliber devices and, to some extent, substitute firing devices. If training devices are to be placed in classrooms, then space, electrical power and climate control must be available.

4.3.2.1 Facilities Factors - ITS. These factors are summarized in Table 4.4. Based on this data, it appears that all of the training device options proposed could be accommodated at ITS.

TABLE 4.4. ITS TRAINING ENVIRONMENT FACTORS - FACILITIES

Live Fire Ranges (Availability/Access) (Planned - August 1984)

- 3 350m rails w/armor moving target carriers
- HE-IT, TP-T, APDS-T from stationary or moving LAV
- Estimate 25% time available for LAV
- Remote Range: Twentynine Palms - 4-hour motor march required

Reduced Scale Ranges

- None currently available, but could be required; if developed, assume unlimited availability/access

Classroom Space

- 240K feet²

Electrical Power

- Yes

Climate Control

- Yes

4.3.2.2 Facilities Factors - Unit. Availability of the required facilities at the unit level vary among sites. Table 4.5 summarizes these factors.

TABLE 4.5. UNIT TRAINING ENVIRONMENT FACTORS - FACILITIES

<u>Unit Location</u>	<u>Range Description</u>	<u>Planned Date</u>
Camp Pendleton	<ul style="list-style-type: none"> ● 3 350m rails w/armor moving target carriers ● HE-IT, TP-T, APDS-T from stationary or moving LAV ● Estimate 25% time available for LAV ● Remote Range: Twentynine Palms 4-hour motor march required 	August 1984
Twentynine Palms	<ul style="list-style-type: none"> ● Same features as Camp Pendleton ● Estimate 33% time available for LAV ● Remote Range: Camp Pendleton 	December 1984
Camp Lejeune	<ul style="list-style-type: none"> ● Armor moving target on one rail ● Limited by requirement to stop boats on inter-coastal waterway to fire on targets ● Cannot fire APDS-T ● Estimate 25% time available for LAV ● Remote Range: Fort Pickett 	In Use
Camp Butler	<ul style="list-style-type: none"> ● Potential use of existing impact areas for stationary LAV to stationary target ● TP-T and HE-IT only ● Primarily for LAV if developed; little flexibility in requirement for lead time in scheduling ● Remote Range: Camp Fuji (Ship Transit Required) 	TBD

Reduced Scale Ranges

- None currently available, but could be developed if required.
- If developed, assume unlimited availability/access.

Classroom Space, Electric Power, Climate Control

- MCB Camp Pendleton -Est BOD Mid-Late 1986, If Funded
- MCAGCC Twentynine Palms -Est BOD Mid-Late 1985, If Funded
- MCB Camp Lejeune -Est BOD Mid-Late 1987, If Funded
- MCB Camp Butler -Maintenance Facility Available Mid-Late 1986
Admin Facility Available Mid 1985, If Funded
By GOJ. Possible GOJ Funded Facility
Available Mid 1984 for LAV CO (REIN)
Requirements

As stated in the table, Camp Pendleton and Twentynine Palms are expected to have range availability in August 1984 and December 1984 respectively, while Camp Lejeune currently has ranges available. Camp Butler has very limited range facilities and it is questionable if or when this will be rectified. However, rather than exclude any training device options based on this data, this study will assume that these resources will be available.

As can be seen from above information, classroom space, electric power, and climate control are scheduled to be available by the mid-1980s. These dates are estimates only. However, for the purpose of this analysis, it is assumed they will be accomplished and, therefore, will not exclude any training device options.

4.3.2.3 Comments. Data on facilities factors are critical to the selection of training device options. Realistic estimates and commitments regarding facilities to be available must be obtained. If this cannot be done, or if the estimates appear subject to change, it is recommended that a "worst case" be presented in the performance specification and that contractors be required to build devices to accommodate the lack of facilities. An example would be the use of training devices provided in self-contained shelters as currently done for some COFTs.

4.3.3 Equipment Factors. Data on two equipment factors was collected; LAV-25 availability and ammunition. Availability of actual equipment is critical if substitute firing devices or the actual equipment alone is scheduled for training. Ammunition available for training must be documented to determine if sufficient amounts are available to accomplish gunnery training using the actual equipment.

4.3.3.1 ITS/Quantity of LAVs. The infantry training school at Camp Pendleton has ten LAV-25s available for instructional use. It is planned that two of the LAVs be utilized as maintenance floats in order to ensure that eight vehicles are constantly in working order. With this number of LAV-25s available, each instructor will have a LAV to use with five trainees. Given that actual equipment is available in this quantity, all of the training device options are acceptable possibilities.

4.3.3.2 ITS/Ammunition. The LAV gunner at ITS will fire the main gun 500 times and is allotted 700 7.62mm rounds for the COAX machine gun. Gunners conduct the majority of their live fire using target practice tracer (TP-T) rounds and, to a lesser extent, with high explosive incendiary tracer (HE-IT). No armor piercing discarding sabot (APDS-T) rounds are available for training. ITS annual training ammunition allowance per trainee is depicted below.

	<u>Quantity</u>	<u>Cost Per Round</u>
● Annual Ammunition Training Allowance		
<u>25mm Main Gun (242)</u>		
●● Armor Piercing Discarding Sabot (APDS-T)	NA	\$50.42
●● High Explosive Incendiary Tracer (HE-IT)	100	46.63
●● Target Practice Tracer (TP-T)	400	30.25
<u>7.62mm COAX (240)</u>		
●● 7.62mm (4 & 1) Linked	700	.34

4.3.3.3 Unit/Quantity of LAVs. The quantity of LAVs at the unit varies depending on unit size. Currently no LAVs have actually been delivered to the various units. The anticipated number of LAVs at each site and the approximate fielding dates are depicted in Table 4.6.

4.3.3.4 Unit/Annual Ammunition Training Allowance. Each LAV three man crew is allotted a certain amount and type of ammunition to be fired annually in training. Table 4.7 provides a complete breakdown of annual allowance of ammunition per year and cost per round.

TABLE 4.6. LAV FIELDING PLAN

UNIT	QTY OF LAV-25s BY FY QTR OR FY				FY-85	TOTAL
	1Q	2Q	3Q	4Q		
CO A (REIN), 1ST LAV BN TWENTYNINE PALMS, CA	17*	21*				16*
3RD LAV BN (-) TWENTYNINE PALMS, CA					39*	39
1ST LAV BN (-) CAMP PENDLETON, CA		39				39
2ND LAV BN CAMP LEJEUNE, NC				6	49	55
CO D (REIN), 3RD LAV BN CAMP BUTLER, OKINAWA					16	16
TOTAL						165

* During FY-85 22 LAV-25s assigned to CO A (REIN), the IOC unit, will be transferred to 3RD LAV Bn. (-).

TABLE 4.7. UNIT ANNUAL AMMUNITION TRAINING ALLOWANCE PER CREW AND COST

<u>Weapon</u>	<u>Quantity</u>	<u>Cost Per Round</u>
● 25mm Main Gun (242)		
oo Armor Piercing Discarding Sabot (APDS-T)	400	50.42
oo High Explosive Incendiary Tracer (HE-IT)	400	46.63
oo Target Practice Tracer (TP-T)	1,200	30.25
● 7.62mm COAX (240)		
oo 7.62mm (4 & 1) Linked	4,800	.34

4.3.3.5 Comments. In the evaluation of actual proposed training device options, availability of LAVs for training is critical if substitute firing devices are to be proposed as training devices for gunnery. Based on available delivery data, sufficient LAVs will be available. If significant reductions occur, then those training devices in the substitute firing device category should be excluded from consideration.

4.4 Trade-Off Criteria

These criteria include both cost and non-cost factors. Cost data is presented in conjunction with a rationale for determining the number of training devices required in each option. The remainder of the criteria are applied to the training devices within each option and ranked based on the rationale presented. Finally, where warranted, comments are presented about the potential use of each criteria in the acquisition process.

4.4.1 Training Device Numbers in Each Option. Criteria for determining number of devices in each option were established for ITS and the unit. These criteria are discussed in the sections that follow.

4.4.1.1 Specify Number of ITS Training Devices. Based upon information gathered from the primary instructors for LAV ITS and other personnel familiar with ITS, several critical factors were determined that impact on the number of training devices required. The following assumptions were made based on this information:

- Assume 48 hours for practice of turret operation/operator maintenance tasks.
- Assume 20 hours for practice of gunnery skills on training devices.
- Assume an instructional cell of 1 instructor and LAV-25 per 5 trainees.
- Assume a total of 8 instructors and 40 trainees.

- Assume a total of 10 LAV-25s (8 LAV-25s for actual training and two LAV maintenance floats).
- Assume training requirement of 1 training device per instructional cell, and maintenance floats to minimize "down time."

The Infantry Training School course is 240 hours long. Driving tasks require 50% of the available time which are out of the scope of this study and shall not be addressed. That leaves a total of 120 hours to be split evenly between turret operations/operator maintenance tasks and gunnery tasks. The breakdown for all ITS hours is depicted in Figure 4.2

Since the number of hours available for hands-on practice in turret operations/operator maintenance tasks and gunnery skills is limited, it is important to have an ample number of training devices to insure optimum use of time. In the same fashion, however, it is undesirable to have so many training devices that the instructor is unable to adequately supervise.

Since an instructional cell of one instructor to five trainees is to be maintained throughout ITS, it was logical to recommend one training device for each of these cells. Each cell has a LAV-25 at its disposal for training. The number of training devices required should be consistent with the number of instructional cells. Since there are 40 trainees per class expected at ITS, and each instructional cell is comprised of five trainees and one instructor, eight training devices are required to train each of the two major HOT task categories. An additional two devices as maintenance floats for each category brings the individual total to ten training devices. Therefore, ten devices were recommended for turret operations/operator maintenance and ten for gunnery skills for options A-E. Option F had fewer devices recommended due to the higher cost of devices comprising that option. Table 4.8 depicts the number of training devices required for ITS.

4.4.1.2 Specify Number of Unit Training Devices. Several critical factors were determined that set parameters on the number of training devices required at the unit. These factors were as follows:

240 HRS FOR TOTAL COURSE

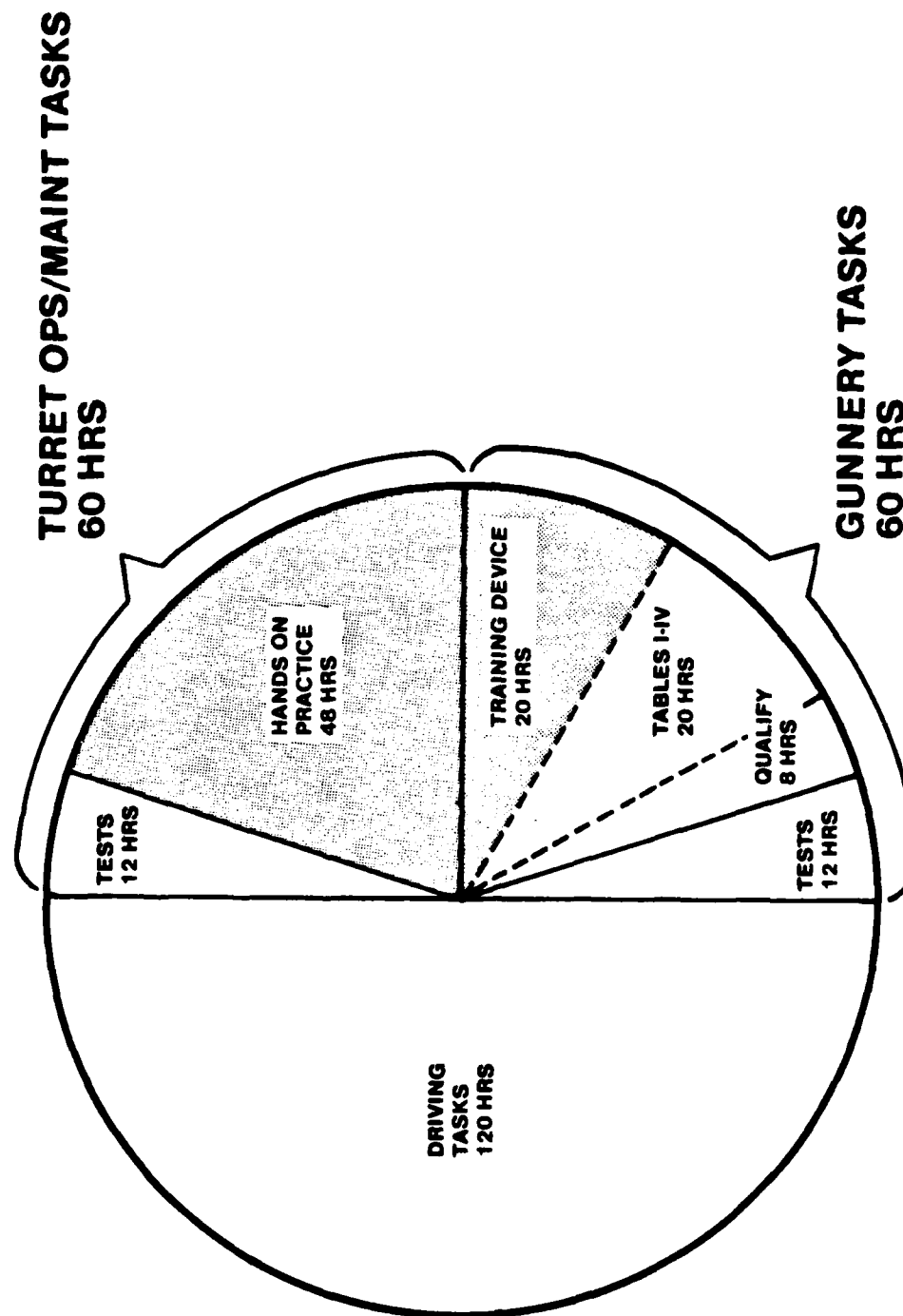


Figure 4.2. ITS Training Time.

TABLE 4.8 NUMBER OF ITS TRAINING DEVICES REQUIRED

LAV HOT TASK CATEGORIES	OPTION A		OPTION B		OPTION C		OPTION D		OPTION E		OPTION F	
	QTY	TRNG DEVICE	QTY	TRNG DEVICE	QTY	TRNG DEVICE	QTY	TRNG DEVICE	QTY	TRNG DEVICE	QTY	TRNG DEVICE
TURRET OPS/MAINT	10	3D Mock-up	10	3D Mock-up	10	3D Mock-up	10	3D Mock-up	10	3D Mock-up	8	Turret Trainer
GUNNERY SKILLS	1	Dynamic Model (COPT)	10	Procedures Trainer (Tabletop)	10	Procedures Trainer (Tabletop)	10	Procedures Trainer (Tabletop)	10	Procedures Trainer (Tabletop)	4	Dynamic Model (COPT)
	10	Procedures Trainer (Tabletop)	10	Substitute Firing Device (Visuals)	10	Subcaliber + Actual Equipment	10	Laser (M55) + Actual Equipment	10	Actual Equipment	2	(CSI)
	10	Actual Equipment	10	Actual Equipment	10	Actual Equipment	10	Actual Equipment	10	Actual Equipment	10	Actual Equipment

- Assume platoon size training included:
 2 instructors
 11 trainees
 4 vehicles
- Assume some flexibility in training schedule so that maintenance float is not as critical as at ITS.
- Assume type and amount of instructional support on the training device can influence the quality of training.
- Assume primary focus of training will be on gunnery skills, although some procedural and maintenance training will also be conducted.

A total of 320 hours of training time is available for LAV crewmen and gunners (MOS 0313) per training year (see Figure 4.1). Of this only 8-10 hours per year are devoted to live firing. That leaves approximately 310 hours of training to be taught with training devices or a combination of training devices and actual equipment. It is important to note that these numbers are the best data available but still are estimates only. It is upon these estimates that assumptions are based and all subsequent analysis is made.

It is assumed that platoon integrity will be maintained during LAV training. Each platoon has four LAV-25s at its disposal. Since a training device such as a subcaliber or substitute firing device is used in conjunction with the actual equipment, a training device is required for each LAV in the platoon. That means four units of each training device is required in the platoon.

As previously depicted in Figure 4.1, approximately 3 days per month are available to each platoon for non-live firing training. The number of devices recommended for each unit is the minimum needed to accomplish training within the assumed 20 day training month. Table 4.9 illustrates the number of devices required at each training site. Table 4.10 provides a description and number of unit devices required for each option.

TABLE 4.9. UNIT TRAINING DATA

<u>SITE</u>	<u>PLATOONS</u>	<u>DEVICES</u>	<u>DAYS TO TRAIN</u>
MCB Camp Pendleton, CA			
● 1st LAV BN(-)	6	4	18
MCAGCC, Twentynine Palms, CA			
● CO A (REIN), 1st LAV BN	3	8	13.5
● 3rd LAV BN(-)	6		
MCB Camp Lejeune, NC			
● 2nd LAV BN	9	8	13.5
MCB Camp Butler, Okinawa			
● CO D (REIN), 3rd LAV BN	3	4	9
TOTAL	27	24	

TABLE 4.10. TRADE-OFF RESULTS (UNIT)

LAV HOT TASK CATEGORIES	NUMBER OF TRAINING DEVICES REQUIRED							
	OPTION A		OPTION B		OPTION C		OPTION D	
	QTY	TRNG DEV	QTY	TRNG DEV	QTY	TRNG DEV	QTY	TRNG DEV
Turret Op/Maint	4	3D Mock-up	4	3D Mock-up	4	3D Mock-up	4	3D Mock-up
Gunnery Skills	4	Dynamic Model (COFT)	24	Substitute Firing Device (Visual)	24	Subcaliber +	4	Dynamic Model (COFT)
		+		+	24	Actual Equipment		+
	24	Substitute Firing Device (Visual)		+	24	Actual Equipment		
		+	24	Actual Equipment				
	24	Actual Equipment						

4.4.2 Cost Estimates. Costs were estimated for each generic type training device considered in this survey. Training devices were divided into three categories; actual equipment, existing training devices, and nonexistent training devices. The results of the estimating process are provided in the following subparagraphs.

4.4.2.1 Actual Equipment Cost Estimate. Actual equipment was considered integral to all trainer options proposed in this survey. Based upon the best available data, the LAV costs approximately \$18 per hour to operate. This figure was not considered a constraint for limiting use of actual equipment in training.

4.4.2.2 Existing Training Device Cost Estimate. Cost estimates were obtained for applicable LAV training devices by contacting the manufacturer of the device and are listed below. The reader is cautioned to accept these cost estimates from contractors to be on the low end of a range compared to the high end of a range. These figures would have to be modified upward for programming and budgeting decisions to account for other cost elements in a Government contract such as data, support, training, provisions, facilities preparation, risk/uncertainty, etc.

<u>Subgroup</u>	<u>Cost/Device</u>
● Subcaliber	\$ 3,000
● M55	3,000
● Substitute Firing Device	80,000
● CSI	2,000,000
● COFT	750,000
● Tabletop	30,000
● Reduced COFT	110,000

The specific contractors contacted were discussed in Section III.

Tables 4.11 and 4.12 depict total cost of each training device option for ITS and unit, respectively. Also included in this table are the number of training devices recommended in each option. Option F (ITS) and Option D (unit) were eliminated because they exceed the established cost ceiling. Any other combination of ITS and unit options are within or near the cost ceiling.

Prior to recommending training device options, it was determined that devices could be further broken down into subgroups within their generic training device category. For example, Actual Equipment with Substitute Firing Device is broken into three subgroups: subcaliber, laser, and CSI (see Table 3.3).

Since E-Tech is recommending generic devices only and not specific training devices, costs within subgroups of the generic category were compared. The highest cost estimate for any device within the subgroup was then used as the price for any of the devices within the subgroup. For example, three different COFTs were identified in the Dynamic Model category. Each COFT varied in procurement costs, however, only the price estimate of the most expensive COFT was utilized when determining training device option costs. When possible to obtain, cost per device estimates were based on procurement of ten or more training devices.

4.4.2.3 Nonexisting Training Device Cost Estimate. E-Tech analysts determined that a 3D mock-up of the LAV turret would provide a cost effective alternative for training turret operator/operator maintenance tasks. The cost of developing and producing the 3D mock-up is estimated at \$151,000 each, based on a total purchase of ten devices, and on the development and production assumptions listed in Appendix D. In support of this figure, a summary of development/production costs reflecting both material and labor is provided in Table 4.13. Operating/support costs were considered relative to the operating/support costs of existing training devices. The values of the estimates were combined in Table 4.14 as a single subjective value (High-Medium-Low) of the combination of existing and nonexisting devices in each option.

TABLE 4.11. COST OF ITS TRAINING DEVICE OPTIONS

LAV HOT TASK CATEGORIES	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION F
	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE
TURRET OPS/MAINT	10 3D MOCKUP COST=1.51M	10 3D MOCKUP COST=1.51M	10 3D MOCKUP COST=1.51M	10 3D MOCKUP COST=1.51M	10 3D MOCKUP COST=1.51M	8 TURRET TRAINER COST=5.01
GUNNERY SKILLS	1 DYNAMIC MODEL (COFT) .75M + 10 PROCEDURES TRAINER (TABLETOP) + .35M 10 SUBSTITUTE FIRING DEVICE (VISUALS) + .8M 10 ACTUAL EQUIPMENT	10 PROCEDURES TRAINER (TABLETOP) + .35M 10 SUBCALIBER + .03M 10 ACTUAL EQUIPMENT	10 PROCEDURES TRAINER (TABLETOP) + .35M 10 LASER (M55) + .03M 10 ACTUAL EQUIPMENT	10 PROCEDURES TRAINER (TABLETOP) + .35M 10 ACTUAL EQUIPMENT	10 PROCEDURES TRAINER (TABLETOP) + .35M 10 ACTUAL EQUIPMENT	DYNAMIC MODEL (COFT) 3M 4 (CSI) 2 (CSI) 4M + 10 ACTUAL EQUIPMENT
TOTAL COST	2.61M	2.66M	1.89M	1.89M	1.86M	12.01M

CAUTION: All existing training device cost figures represent hardware costs only and are based on estimates from industry. Their application to budgeting and planning should also consider factors delineated in paragraph 4.4.2.2.

TABLE 4.12. COST OF UNIT TRAINING DEVICE OPTIONS

LAV HOT TASK CATEGORIES	OPTION A	OPTION B	OPTION C	OPTION D
	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE	QTY TRNG DEVICE
TURRET OP/MAINT	4 3D MOCKUP COST=.604M	4 3D MOCKUP COST=.604M	4 3D MOCKUP COST=.604M	4 TURRET TRAINER COST=2.4M
GUNNERY SKILLS	4 DYNAMIC MODEL (COFT) 3M + 24 SUBSTITUTE FIRING DEVICE (VISUALS) + 1.92M 24 ACTUAL EQUIPMENT	24 SUBSTITUTE FIRING DEVICE (VISUALS) + 1.92M 24 ACTUAL EQUIPMENT	24 SUBCALIBER + .072M 24 ACTUAL EQUIPMENT	4 DYNAMIC MODEL (COFT) 3.0M + 24 SUBSTITUTE EQUIPMENT DEVICE + ACTUAL EQUIPMENT 1.92M
TOTAL COST	5.524M	2.524M	.676M	7.32M

CAUTION: All existing training device cost figures represent hardware costs only and are based on estimates from industry. Their application to budgeting and planning should also consider factors delineated in paragraph 4.4.2.2.

TABLE 4.13. LAV TURRET TRAINER COST ESTIMATE SUMMARY
3D MOCK-UP

<u>CATEGORY</u>	<u>FIRST TRAINER</u>	<u>EACH ADDITIONAL TRAINER</u>	<u>AVERAGE BASED ON 10 TRAINERS</u>
SYSTEM DESIGN	\$ 10,600	\$ N/A	\$ 1,060
PROGRAM MANAGEMENT	25,300	12,700	13,960
RAM/QUALITY CONTROL	9,500	9,500	9,500
MECHANICAL DESIGN	113,600	53,900	59,870
ELECTRICAL DESIGN	36,100	20,700	22,240
LOGIC/SOFTWARE DESIGN	31,700	N/A	3,170
FABRICATION	8,900	8,900	8,900
SYSTEM INTEGRATION/DEBUG	19,400	19,400	19,400
DOCUMENTATION	<u>12,900</u>	<u>12,900</u>	<u>12,900</u>
TOTAL EACH	\$268,000	\$138,000	\$151,000

CAUTION: All existing training device cost figures represent hardware costs only. Their application to budgeting and planning should also consider factors delineated in paragraph 4.4.2.2.

**TABLE 4.14. RELATIVE VALUES OF OPERATING/SUPPORT COSTS OF
EXISTING AND NONEXISTING TRAINING DEVICES**

ITS		UNIT	
OPTION A <ul style="list-style-type: none"> ● 3D MOCK-UP ● COFT ● PROCEDURES TRNR (TABLETOP) ● ACTUAL EQUIPMENT 	HIGH	OPTION A <ul style="list-style-type: none"> ● 3D MOCK-UP ● COFT ● SUBST. F.D. ● ACTUAL EQUIPMENT 	HIGH
OPTION B <ul style="list-style-type: none"> ● 3D MOCK-UP ● PROCEDURES TRNR (TABLETOP) ● SUBST. F.D. ● ACTUAL EQUIPMENT 	MED	OPTION B <ul style="list-style-type: none"> ● 3D MOCK-UP ● SUBST. F.D. ● ACTUAL EQUIPMENT 	LOW
OPTION C <ul style="list-style-type: none"> ● 3D MOCK-UP ● SUBCALIBER ● PROCEDURES TRNR (TABLETOP) ● ACTUAL EQUIPMENT 	MED	OPTION C <ul style="list-style-type: none"> ● 3D MOCK-UP ● SUBCALIBER ● ACTUAL EQUIPMENT 	LOW
OPTION D <ul style="list-style-type: none"> ● 3D MOCK-UP ● M55 LASER ● PROCEDURES TRNR (TABLETOP) ● ACTUAL EQUIPMENT 	MED		
OPTION E <ul style="list-style-type: none"> ● 3D MOCK-UP ● PROCEDURES TRNR (TABLETOP) ● ACTUAL EQUIPMENT 	LOW		

LEGEND:

HIGH \$240K or Above
MED \$130K to \$230K
LOW Below \$130K

4.4.2.4 Comment - Cost. As demonstrated by training device options in the trade-off, the Government cost ceiling allows for considerable flexibility in the composition of the training device options. It can be assumed that contractors will be able to propose training device options, which include state-of-the-art technology, in sufficient quantities to insure availability for training.

4.4.3 Non-Cost Results. Non-cost criteria include the following criteria:

- Fidelity
- Reliability and Maintainability
- Update/Modifiability
- New Engineering Design Work
- Technological Development
- User Acceptance
- Instructional Support

All training devices in each option were ranked high, medium or low for each criteria. The results of this ranking are presented where appropriate in tables associated with the discussion of each non-cost criteria. The rationale for each ranking is discussed in the remainder of this section.

4.4.3.1 ITS/Unit Fidelity Rankings. As discussed in Section II, fidelity factors considered critical included the physical and functional fidelity of the hardware associated with the performance of gunnery skills and two visual fidelity factors, range of combat environments and fidelity of gunnery cues. Range of combat environments include such factors as terrain, atmospheric conditions and threat activity. Fidelity of gunnery cues refers to those target cues required for the gunner to fire successfully on a target. Requirements for target characteristics were based on analysis of LAV gunnery tasks and are shown in Appendix K. The rankings of the training devices which comprise ITS and unit training device options are shown in Table 4.15 and Table 4.16. These rankings are discussed in the remainder of this section.

TABLE 4.15. FIDELITY RANKINGS - ITS

	EQUIPMENT FIDELITY	FULL RANGE OF COMBAT ENVIRONMENTS	FIDELITY OF GUNNERY CUES
OPTION A			
• COFT	HIGH	HIGH	MED
• PROCEDURE TRAINER (TABLETOP)	LOW	HIGH	MED
• ACTUAL EQUIPMENT	HIGH	N/A	N/A
OPTION B			
• ACTUAL EQUIPMENT W/SUBSTITUTE FIRING DEVICES	HIGH	MED	HIGH
• PROCEDURE TRAINER (TABLETOP)	LOW	MED	MED
OPTION C			
• SUBCALIBER W/ ACTUAL EQUIPMENT	HIGH	LOW	LOW
• PROCEDURE TRAINER (TABLETOP)	LOW	MED	MED
OPTION D			
• LASER (M55) W/ ACTUAL EQUIPMENT	HIGH	LOW	LOW
• PROCEDURE TRAINER (TABLETOP)	LOW	MED	MED
OPTION E			
• PROCEDURE TRAINER (TABLETOP)	LOW	MED	MED
• ACTUAL EQUIPMENT	HIGH	N/A	N/A

TABLE 4.16. FIDELITY RANKINGS - UNIT

	EQUIPMENT FIDELITY	FULL RANGE OF COMBAT ENVIRONMENTS	FIDELITY OF GUNNERY CUES
OPTION A			
• COFT	HIGH	HIGH	MED
• SUBSTITUTE F.D. W/ACTUAL EQUIP.	HIGH	MED	HIGH
OPTION B			
• SUBSTITUTE F.D. W/ACTUAL EQUIP.	HIGH	MED	HIGH
OPTION C			
• SUBCALIBER W/ ACTUAL EQUIPMENT	HIGH	LOW	LOW

4.4.3.1.1 Turret Operations/Operator Maintenance HOT Tasks. The 3D mock-up is the only training device considered for ITS or unit turret operation/operator maintenance training. Since it has been specified to meet all fidelity requirements, if built, it would rank high in fidelity.

4.4.3.1.2 Gunnery HOT Tasks. The rationale for the ranking of each training device is presented in the remainder of this section.

COFT - Equipment Fidelity - High. COFT type training devices surveyed provided hardware simulation which duplicated the actual equipment such that there was not discernable difference. This included duplication of physical fidelity as well as functional fidelity.

COFT - Range of Combat Environments - High. The visual scenes available on "COFT-like" devices are capable of presenting any combat environment required, to include terrain variations as well as any number and configuration of threat vehicles.

COFT - Fidelity of Gunnery Cues - Med. All COFT systems evaluated used some form of computer generated imagery (CGI). Although these CGI images are judged by some subject matter experts to be adequate for practice of gunnery skills, they do not provide the same degree of realism (physical fidelity) as film or video disk. Therefore, a rank of medium was assigned.

Procedures Trainer (Tabletop) - Equipment Fidelity - Low. Although two critical pieces of hardware - the hand control and the optical sight - can be configured for high physical and functional fidelity, there is no attempt to simulate any of the other hardware components which would be involved in the practice of the identified LAV gunnery tasks. Compared with all other training devices, this provided the least hardware fidelity.

Procedures Trainer (Tabletop) - Range of Combat Environments - Med. The tabletop trainer observed by E-Tech staff did have the potential to present the full range of combat environments. At the present time, this range was limited by access to threat vehicles which could be used for filming of scenarios and by the number of scenarios available which totaled approximately 20. Since it remains to be determined that all potential threat vehicles would, in fact, be available and could be photographed in the full range of combat environments, a rank of medium was assigned.

Procedures Trainer (Tabletop) - Fidelity of Gunnery Cues - Med. The video disk scene currently available on the tabletop trainer observed had a grainy appearance which impaired observation for the critical gunnery cues. While this may or may not detract from transfer of training, it does not present realistic cues. Another limiting factor for this type of training device is the inflexibility of the threat

movement. Within any given exercise presented, the threat(s) are located and move exactly the same like seeing a TV commercial more than once. A trainee can very quickly, after one or two viewing of any given scenario, anticipate where the threat will be located, the type ammo to be required and the projected movement. While this can be alleviated by presentation of a greater number of scenarios and random presentation of targets, this remains to be proven practical from a cost vantage. Thus a rank of medium was assigned.

Substitute Firing Devices w/Actual Equipment - Equipment Fidelity - High. Since both substitute firing devices observed required the use of the hardware in the actual equipment for practice, the ranking of high was assigned.

Substitute Firing Devices w/Actual Equipment - Range of Combat Environments - Med. The range of combat environments which can be provided for practice is limited to those available at the training site. The advantage of the substitute firing devices over a subcaliber device is that since the live ammo firing is computer simulated and targets can be computer simulated, the range of possible environments, while not as great as the COFT devices, is ranked medium since it is greater than that of the subcaliber, which is limited to range environments.

Substitute Firing Devices w/Actual Equipment - Fidelity of Gunnery Cues - High. The two substitute firing devices observed provided gunnery cues using objects in the actual environment. Thus, although the variety of such targets may be limited as noted above, the cues available are as realistic as those in a real world environment. In addition, the burst on target of the simulated firing provides cues for sensing. Thus, a rank of high was assigned.

Subcaliber w/Actual Equipment - Equipment Fidelity - High. Since all procedures are accomplished with the actual equipment, the ranking assigned was high.

Subcaliber w/Actual Equipment - Range of Combat Environments - Low. The range of combat environments which can be presented using subcaliber devices is very limited since the use of live ammunition restricts the terrain choice and threat targets to those available on the range used. Thus, a ranking of low was assigned.

Subcaliber w/Actual Equipment - Fidelity of Gunnery Cues - Low. The range of gunnery cues is likewise limited by the characteristics of available range targets, especially in showing motion and threat perspectives. In addition, sensing may not be possible if tracers are not visible or unavailable. The ranking assigned was low.

Laser (M55) w/Actual Equipment - Equipment Fidelity - High. Use of the actual equipment for practice of all procedures dictates that this training device be ranked high.

Laser (M55) w/Actual Equipment - Range of Combat Environments - Low. While the laser is not limited to use on a firing range, its maximum range of 10-12 meters results in a ranking of low.

Laser (M55) w/Actual Equipment - Fidelity of Gunnery Cues - Low. Gunnery cues are very limited on the M55. The use of 4-ft. wide silhouettes as targets limits practice of target identification. The ability to "pull lead" is not practical and sensing is not possible since there is no visual to simulate burst on target. Laser rounds are sensed as either a hit or no-hit and indicated by using a retro-reflective device attached to the target.

4.4.3.1.3 Comment - Fidelity. All three factors of fidelity, equipment fidelity and the two visual fidelity requirements, the range of combat environments and gunnery cues, require well documented requirements if prospective contractors are to be able to propose realistic cost estimates. The data needed to specify fidelity requirements can be obtained from the Task and Media Analysis although it must be updated to the current LAV configuration. The data needed to specify visual fidelity requirements remains to be detailed, although in general terms it is provided in Appendix K.

4.4.3.1.4 Recommendation. It is recommended that the fidelity requirements be specified by task in the performance specification and the same fidelity requirements, in turn, be used to rank the probable training effectiveness of any proposed training options.

4.4.3.2 Reliability and Maintainability Evaluation. MTBF and MTTR were considerations in evaluating the reliability of the 3D mock-up. Where possible estimates were based on a minimum standard of 400 hours MTBF and 1 hour MTTR. The reliability and maintainability (RAM) evaluation consisted of a relative comparison of the 3D mock-up, existing devices, and actual equipment based on general assumptions such as the complexity of the devices being evaluated and experience with other devices with comparable features. Table 4.17 displays subjective values (high, medium or low) assigned to each type training device within each trainer option based on their relative merits.

4.4.3.3 Update/Modifiability Evaluation. Each training device type under consideration was evaluated with regard to the ease and ability of the device to be updated or modified. This is a difficult criteria to evaluate because of the wide differences in complexity of training devices with respect to the wide differences in complexity of modifications that may be required. Logically, the more complex the training device, the more complex the incorporation of a change may be. In actuality, the reverse may be true in some cases. For example, changing scenery and target sequence could be done at a keyboard in a very complex device, but would require a new video disk or software change in a less complex device. In other words, it depends on the update or modification to accurately judge which device would be easier to update or modify. To effectively evaluate options in this area, a representative sample of types of changes possible for each option and contacts with personnel in the field with experience with devices having similar attributes, were used in arriving at the ratings of each type (see Table 4.17).

TABLE 4.17. TRADE-OFF RESULTS - NON-COST, RAM AND MODIFIABILITY

ITS

UNIT

	RELIABILITY/ MAINTAIN- ABILITY	UPDATE/ MODIFI- ABILITY
OPTION A		
• 3D MOCK-UP	HIGH	HIGH
• COFT	HIGH	MED
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION B		
• 3D MOCK-UP	HIGH	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• SUBST. F.D.	LOW	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION C		
• 3D MOCK-UP	HIGH	HIGH
• SUBCALIBER	HIGH	N/A
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION D		
• 3D MOCK-UP	HIGH	HIGH
• M55 LASER	MED	MED
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION E		
• 3D MOCK-UP	HIGH	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	LOW	LOW

	RELIABILITY/ MAINTAIN- ABILITY	UPDATE/ MODIFI- ABILITY
OPTION A		
• 3D MOCK-UP	HIGH	HIGH
• COFT	HIGH	MED
• SUBST. F.D.	LOW	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION B		
• 3D MOCK-UP	HIGH	HIGH
• SUBST. F.D.	LOW	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION C		
• 3D MOCK-UP	HIGH	HIGH
• SUBCALIBER	HIGH	N/A
• ACTUAL EQUIPMENT	LOW	LOW

4.4.3.4 Comment - Update/Modifiability Risk. This criteria was, at best, difficult to assess in the trade-off analysis, and it will be likewise so in any actual procurement unless specific changes are used to judge the potential for update and modifiability. It is recommended that unless specific changes and/or systems are proposed, that this criteria should be limited to the ability of device computer systems to incorporate software changes and to support additional I/O devices .

4.4.3.5 New Engineering Design Risk Evaluation. The various training devices being considered in this study were evaluated in light of the potential risk of delayed production and delivery of the devices due to new engineering design requirements. Each device, other than actual equipment, would require some degree of new engineering design to simulate or resemble LAV characteristics. However, in the aggregate each trainer option was judged essentially equal to the other options with regard to new design risks that could cause delays in delivery.

4.4.3.6 Technological Development Risk Evaluation. Each training device being considered in this study was evaluated with regard to the risk of unsuccessful development due to the requirement for technology that has not yet been proven or fully developed. None of the devices is expected to require new technology to permit training the LAV tasks as designated for each type device. Therefore, all were assigned a low risk rating in this category.

4.4.3.7 Comment - New Engineering Design Work Risk/Technological Development Risk. These factors were not critical to the trade-off since most options considered existing technologies in existing training devices. It is not anticipated to be a critical factor in the LAV procurement unless an option proposes an untried technology. It is recommended that both be retained as a factor for evaluation but applied only if practicable.

4.4.3.8 User Acceptance. This factor had very little documented information available. Where possible, judgments were made on rankings based on discussions with subject matter experts who had used the devices for training (see Table 4.18). In cases where the device had not been fielded by any military service, then judgments were made by E-Tech staff based on the device configuration.

TABLE 4.18. USER ACCEPTABILITY RANKING

ITS

	PERCEIVED VALUE	EASE OF USE
OPTION A		
• 3D MOCK-UP	MED	HIGH
• COFT	HIGH	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	HIGH	HIGH
OPTION B		
• 3D MOCK-UP	MED	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• SUBST. F.D. W/ ACTUAL EQUIPMENT	MED	LOW
OPTION C		
• 3D MOCK-UP	MED	HIGH
• SUBCALIBER W/ ACTUAL EQUIPMENT	MED	MED
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
OPTION D		
• 3D MOCK-UP	MED	HIGH
• M55 LASER W/ ACTUAL EQUIPMENT	MED	MED
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
OPTION E		
• 3D MOCK-UP	MED	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	HIGH
• ACTUAL EQUIPMENT	HIGH	MED

UNIT

	PERCEIVED VALUE	EASE OF USE
OPTION A		
• 3D MOCK-UP	MED	HIGH
• COFT	HIGH	HIGH
• SUBST. F.D. W/ ACTUAL EQUIPMENT	MED	LOW
OPTION B		
• 3D MOCK-UP	MED	HIGH
• SUBST. F.D. W/ ACTUAL EQUIPMENT	MED	LOW
OPTION C		
• 3D MOCK-UP	MED	HIGH
• SUBCALIBER W/ ACTUAL EQUIPMENT	MED	MED

3D Mock-Up - Perceived Value - Med. The 3D Mock-Up as proposed, provides high equipment fidelity only on those portions of the turret which are used in the accomplishment of the LAV HOT tasks concerned with turrent operation/operator maintenance. Due to the different levels of fidelity, the 3D Mock-up may be perceived by the user to be of less value than practice on the actual equipment. Therefore, a rank of medium was assigned.

3D Mock-Up - Ease of Use - High. Since the 3D Mock-up is designed to be self-contained, with little if any set-up required beyond actuating the power, a ranking of high was assigned.

COFT - Perceived Value - High. The COFT type training devices have been well received in the field based on subject matter expert reports. Given the high fidelity, immediate feedback the user receives and the game-like nature of the trainee activity, E-Tech analyst assigned a high ranking.

COFT - Ease of Use - High. The COFT devices observed by E-Tech staff appeared to be configured such that instructor operation and maintenance requirements were easy to accomplish by typical military personnel. These observations were confirmed by personnel familiar with its use in the Army. Therefore, a ranking of high was assigned.

Procedures Trainer (Tabletop) - Perceived Value - Med. Military personnel who have seen the tabletop trainer cited as the sample device, have mixed reactions as to its perceived value. While none will deny that its "game" appeal is high, many express doubts that it has any real training value. Based on these reactions the ranking assigned was medium.

Procedures Trainer - Ease of Use - High. Military personnel currently using the device are unanimous on a ranking of high for this factor, since it is very simple to operate.

Substitute Firing Device - Perceived Value - Med. These devices have not yet been fielded in the United States. Rankings were based on E-Tech analyst judgments and conversations with LAV Marine Corps personnel familiar with the devices through demonstrations. The ranking assigned was medium.

Substitute Firing Device - Ease of Use - Low. The ranking of this factor is based on the observation by E-Tech analysts and LAV personnel, that six or more pieces of equipment must be correctly attached to the actual equipment. This activity may or may not be easy to accomplish by field personnel but certainly involves more effort than any of the other training devices proposed, therefore a rank of low was assigned.

Subcaliber - Perceived Value - Med. Based on conversations with training personnel who have used this device for gunnery training, a ranking of medium was assigned. They felt that it did provide the training of the gunnery tasks it was purported to train and that this training appeared to transfer to use of the actual equipment on the range.

Subcaliber - Ease of Use - Med. As with the substitute firing device, the subcaliber requires preparation for use since it must be properly attached to the actual equipment and then subsequently removed and stored. Since only one piece of equipment is actually attached to the LAV and this is accomplished rather easily based on conversations with training personnel, the ranking assigned was medium.

M55 Laser - Perceived Value - Med. Training personnel who have used this device indicated that its ranking should be similar to that of the subcaliber. Again, the training provided by using this device appeared to transfer to use of the actual equipment within the limited range of gunnery skills it is designed to train.

M55 Laser - Ease of Use - Med. Conversations with training personnel indicate that a ranking of medium should be assigned for this training device. It must be attached to the actual equipment, therefore coordination is required for scheduling of both vehicle and device, but the actual attachment of the device is not complicated.

4.4.3.8.1 Comment. User acceptance probably impacts the actual use of a training device more than any other factor considered, yet, it cannot be specified in the performance specification, and is very difficult to evaluate unless the devices have been used in the field.

4.4.3.8.2 Recommendation. It is recommended that prospective training devices which lack data on user acceptance be demonstrated at a LAV training site and that potential users assist in developing a criteria to assess potential acceptability. For those devices in current use, these same criteria should be used to confirm reported user acceptability. This data can be used by the government to evaluate proposed training device options with some degree of consistency.

4.4.3.9 Instructional Support. Instructional support refers to training device features that provide the student with feedback during training, and assist the instructor in monitoring, tracking and testing trainees. By definition, actual equipment does not include instructional support except when the actual equipment has embedded training features. Rankings are summarized in Table 4.19.

The 3D mock-up is ranked low in both student and instructor instructional support. Concerning performance of task sequence, the trainee will receive no additional feedback not normally provided by the actual equipment and must, therefore, rely on the instructor for instructional support. The instructor can insert faults into the system, such as simulating a jammed gun, but receives no indication intrinsic to the device that the trainee has performed correctly.

TABLE 4.19. ITS INSTRUCTIONAL SUPPORT FOR TRAINING DEVICE ACROSS UNIT OPTIONS

ITS

	STUDENT	INSTRUCTOR
OPTION A		
• 3D MOCK-UP	LOW	LOW
• COFT	HIGH	HIGH
• PROCEDURES TRNR (TABLETOP)	MED	LOW
• ACTUAL EQUIPMENT	LOW	LOW
OPTION B		
• 3D MOCK-UP	LOW	LOW
• PROCEDURES TRNR (TABLETOP)	MED	LOW
• SUBST. F.D.	HIGH	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION C		
• 3D MOCK-UP	LOW	LOW
• SUBCALIBER	LOW	LOW
• PROCEDURES TRNR (TABLETOP)	MED	LOW
• ACTUAL EQUIPMENT	LOW	LOW
OPTION D		
• 3D MOCK-UP	LOW	LOW
• M55 LASER	MED	LOW
• PROCEDURES TRNR (TABLETOP)	MED	LOW
• ACTUAL EQUIPMENT	LOW	LOW
OPTION E		
• 3D MOCK-UP	LOW	LOW
• PROCEDURES TRNR (TABLETOP)	MED	LOW
• ACTUAL EQUIPMENT	LOW	LOW

UNIT

	STUDENT	INSTRUCTOR
OPTION A		
• 3D MOCK-UP	LOW	LOW
• COFT	HIGH	HIGH
• SUBST. F.D.	HIGH	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION B		
• 3D MOCK-UP	LOW	LOW
• SUBST. F.D.	HIGH	HIGH
• ACTUAL EQUIPMENT	LOW	LOW
OPTION C		
• 3D MOCK-UP	LOW	LOW
• SUBCALIBER	LOW	LOW
• ACTUAL EQUIPMENT	LOW	LOW

The COFT ranked high on both student and instructor instructional support. This device provides instructional support to the student in a variety of ways. Upon exercise completion, the trainee can view the entire lesson on a video recording and is provided a printed copy of number of hits and misses, and type of ammo used. During the exercise, the instructor can view the lesson from a video display and input faults via a microcomputer. An accurate accounting of the trainee's scores, competency level, and improvement can be maintained with the printed copy of exercise results.

Procedures trainers have been ranked medium for student instructional support. Instructional support provided by these devices enhances training to a lesser extent than the COFT or substitute firing devices. For example, the trainee receives auditory cues (fire commands) prior to firing and can engage targets using burst on target method. Also, number of shots fired and number of hits are displayed on a small CRT screen. However, no capabilities exist for the trainee to view a replay of his performance on a video recording, or receive a printed copy of his results as there is with the COFT. Instructor instructional support is very limited and consequently ranked low. The instructor can view the entire scenario on an adjacent video screen but is unable to insert faults, change the scenarios, or receive documentation of trainee performance. Procedures trainers are designed for feedback to the user and not instructor.

Substitute firing devices provide a high level of instructional support to the trainee and instructor. The trainee receives a printed copy of the gunnery exercise results that includes number of rounds fired, number of hits and misses, and error magnitude. The instructor can input type of target, range of target, and ammo to be used. As with the COFT, the instructor can determine the trainee's performance based on a printed copy of exercise results depicting number of shots fired, shots remaining, probability of kill, etc. As an option, video display of the entire exercise is available.

Subcaliber devices were ranked low for both instructional support factors since no instructional support is provided the trainer or instructor.

The M55 Laser is attached to the actual equipment and was ranked low for the same reasons as the subcaliber devices.

Actual equipment was ranked low for both the student and instructor. No features intrinsic to the actual equipment exists that are designed to provide instructional support. By definition, instructional support pertains to characteristics of the device that are designed specifically to enhance training. Since the actual equipment does not have any such features, it is therefore ranked low.

4.4.3.9.1 Comment - Instructional Support. The data available on the instructor student ratio will provide contractors with some indication of the degree of instructional support required at the training sites. However, if cost estimates are to be accurate, additional guidance on the level of student feedback desired and the data collection required for the instructor to perform his duties should be provided in the performance specification. This can be determined as the ITS and unit training plans are refined and should be included in the performance specification as well as used as an evaluative factor.

4.5 Summary

As discussed in the introduction, the value of this study lies in being able to conduct a hypothetical solicitation process. In accomplishing this, sample training device options and evaluative factors were developed. The evaluative factors were subsequently applied in the ranking of training device options.

In this study a total of five ITS and three unit training device options were developed. These options represent combinations of training devices which were determined to be practical solutions for LAV training. With one exception, all devices proposed are existing devices which will facilitate rapid acquisition. Options possess the required media attributes to train all LAV HOT tasks and accommodate constraints found at each training site. All options can be acquired in suitable numbers to provide efficient training yet remain within the funding ceiling.

Standards used to develop these options can be used to support the solicitation process. The performance specification should provide tasks to be trained, personnel data detailed such that the numbers of devices can be determined, and finally realistic descriptions of training environment constraints so that required facility resources can be assessed. Rationale for each offerer's solution to these parameters should be required in each proposal. This will insure that the offerer is appropriately addressing the training situation and provides a relatively uniform way of evaluating the responses. Assuming that all offerers provide reasonable solutions to the solicitation within a fixed cost ceiling, then the trade-off criteria can be used to rank and evaluate proposals.

A total of eight trade-off criteria were used in this study. Some were found to be of more value than others. Certainly cost is a consideration and will be used to eliminate those proposals which are excessive and then to rank in terms of best value. Fidelity is a valuable factor but must be well defined relative to the type of tasks addressed by the training device.

As discussed in the study, hardware fidelity and the fidelity of the visuals required for gunnery training should be considered separately. To assure that the training devices proposed provide the required fidelity, the performance specification should detail the minimum functional and physical fidelity requirements. The task and media analysis provides the data base for the hardware fidelity. A similar data base can be developed for the visual fidelity requirements.

User acceptance, although critical to the success of any training device, will prove difficult to specify both in the performance specification and as a factor for evaluation. Since it is anticipated that all options will be comprised of existing training devices, they should be evaluated specifically for acceptability by users in field conditions so that a practical evaluation can be made regarding potential for user acceptance.

Instructional support requirements were determined to be a valuable factor, with the level of support required varying depending on the training site and nature of the device. The performance specification should provide offerers with data such as instructor/student ratio and entry and exit performance requirements so the instructional support requirements can be determined as they apply to each device. The rationale and full description of instructional support proposed should be required.

Reliability and maintainability is a factor which requires a standard to be met. Update, modifiability requirements must be specified in detail if offerers are to address them.

Finally, new design risk and technical development risk were judged to be of limited value and should be applied only as the need dictates.

In conclusion, the analysis provides support for the assumption that practical training device options for the LAV can be developed using primarily existing training devices. The key to both development and evaluation of these options lies in the data provided in the performance specification and subsequent Government evaluation using the factors discussed in the report.

AD-A138 424

LIGHT ARMORED VEHICLE (LAV) TRAINING EQUIPMENT SURVEY
FOR THE US MARINE CORPS (U) EAGLE TECHNOLOGY INC ORLANDO
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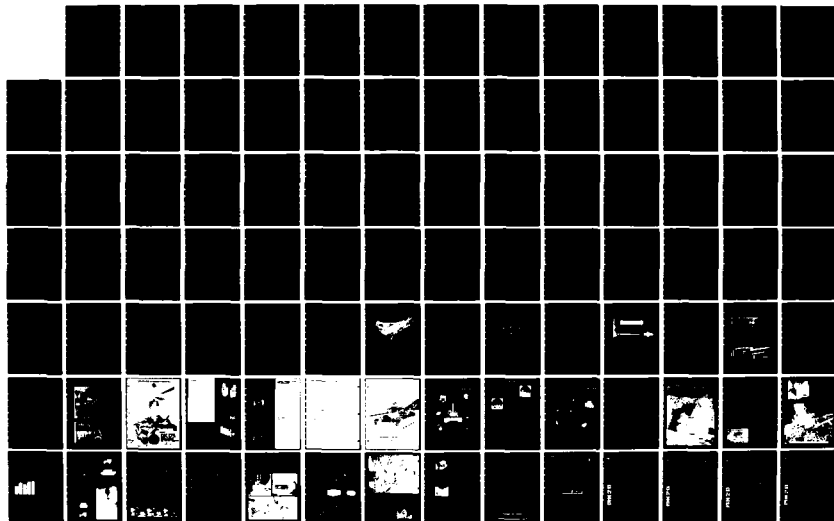
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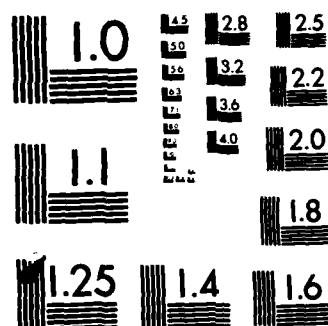
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MICROCOPY RESOLUTION TEST CHART
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APPENDIX A

**SUMMARY OF STUDENT ACTIONS FOR LAV
HANDS-ON TRAINING (HOT) TASK CATEGORIES**

APPENDIX A

SUMMARY OF STUDENT ACTIONS FOR LAV HANDS-ON TRAINING (HOT) TASK CATEGORIES

1. Maintenance Actions

- 1.1 Performs tasks in accordance with checklist.
- 1.2 Performs tasks in restrictive environment.
- 1.3 Performs tasks with help of crew member.
- 1.4 Locates, manipulates, and visually verifies controls and indicators.
- 1.5 Disconnects connectors to equipment being removed.
- 1.6 Unseats and seats equipment from rack/frame/mount.
- 1.7 Assembles/disassembles major equipment parts.
- 1.8 Cleans and lubricates equipment.
- 1.9 Performs troubleshooting procedures based on equipment status.

2. Immediate Actions

- 2.1 Performs tasks in accordance with checklist.
- 2.2 Performs tasks in restrictive environment.
- 2.3 Performs tasks with help of crew member.
- 2.4 Locates, manipulates, and visually verifies controls and indicators.
- 2.5 Disconnects connectors to equipment being removed.
- 2.6 Unseats and seats equipment from rack/frame/mount.
- 2.7 Assembles/disassembles major equipment parts.
- 2.8 Cleans and lubricates equipment.
- 2.9 Performs troubleshooting procedures based on equipment status.
- 2.10 Performs procedures within a time constraint.

3. Ammo Handling

- 3.1 Performs tasks in accordance with checklist.
- 3.2 Performs procedures within restrictive environment.
- 3.3 Performs tasks with help of crew member.
- 3.4 Uploads and downloads ammunition, observing proper safety handling procedures.

4. Turret Operations

- 4.1 Performs tasks in accordance with checklist.
- 4.2 Locates, manipulates and visually verifies controls and indicators.
- 4.3 Energizes turret equipment and monitors status.
- 4.4 Manipulates turret controls and verifies associated movement.
- 4.5 Listens for audio confirmation of turret hydraulic operation.

5. Gunnery Skills

- 5.1 Sets turret and weapon system ready for fire in accordance with checklist.
- 5.2 Maneuvers gun and turret manually and with powered drive.
- 5.3 Interprets visual motion feedback via optical sights, periscopes, and open hatches.
- 5.4 Identifies target; determines greatest threat; determines range; selects proper ammo and weapon; fires at target; and uses proper fire command voice procedures.
- 5.5 Interprets tracer and sensing feedback.
- 5.6 Employs proper adjustment procedures to hit target.

6. Boresighting Procedure

- 6.1 Maneuvers gun and turret manually with powered drive (gunner).
- 6.2 Identifies boresight target 1,000 M away through optical sight (gunner).

6. Boresighting Procedure (cont)

- 6.3 Installs boresighting rod (crewman).
- 6.4 Ensures gunner and crewman are looking at same target (gunner/crewman).
- 6.5 Adjusts optical sight reticle knobs (gunner).
- 6.6 Avoids any hull movement (crewman).

APPENDIX B

LAV LITERATURE SEARCH METHODOLOGY

APPENDIX B

LAV LITERATURE SEARCH METHODOLOGY

The literature search obtained data primarily from Government publications, Manpower and Training Information System (MATRIS), Work Unit Search, Defense Technical Information Center (DTIC), Work Unit Search, and DTIC Technical Report Search.

Government publications such as Field Manuals and Department of Army Pamphlets were obtained from the E-Tech technical library and were beneficial in identifying training devices in the U.S. Government inventory.

In February 1983, a MATRIS search was requested. This initially involved contacting a MATRIS representative via telephone and making a verbal request for the search. Next, a letter documenting the search need was prepared and sent to the MATRIS office in San Diego, California, to confirm the telephone request. The research requested was for the topic area GUNNERY TRAINERS and GUNNERS.

Subtopic areas specified included:

- Air Combat Training - Gunnery
- Air Defense Training - Gunnery
- Gunfire Simulation
- Gunnery Trainers
- Helicopter Machine Gunner Training
- Tank Training - Gunnery
- Gunners - Machine Gun and Tank

The search was limited to work unit descriptions that were unclassified and not older than 10 years.

A DTIC Work Unit Search was also performed in the literature search process. As one of its major functions, DTIC maintains the Research and Technology Work Unit Information System (WUIS), which contains research project descriptions at the work unit level, that have been or are currently being performed by DoD and NASA, or under DoD contract.

As a check on and supplement to the MATRIS search, a WUIS search was initiated. This search was requested via an Information Request (DTIC Form 4, JAN 81) which was sent to the DTIC offices at Cameron Station, Alexandria, Virginia. In making this request, a broad coverage search was specified, covering the last ten years in the area of TRAINING DEVICES. In conducting the WUIS search, DTIC personnel employed a two step strategy.

In the first step the following topic area terms were selected for the search:

- Armored Personnel Carriers
- Armored Vehicles
- Gun Turrets
- LAV
- Light Armored Vehicles
- Tank Turrets
- Tanks (Combat Vehicles)

The second step search items selected were:

- Gunnery Trainers
- Training Devices
- Training Films
- Training Gear

All work unit citations having a CONFIDENTIAL or SECRET classification were excluded from consideration in conducting the search. This was judged to be a reasonable exclusion since the interest of the search was to identify any "mainstream" work units missed by the MATRIS search.

In addition to the WUIS, the DTIC maintains a collection of over one million technical reports which are accessible through a computerized bibliographic system and an additional 300,000 documents available for manual searching. All technical reports entered into the computerized bibliographic system have been coded via a number of specific descriptors or key words, e.g., Armor Training, Gunners, training, transfer of training. As a consequence, bibliographic searches of the technical report data base are easily accomplished and are performed on a no cost basis for DoD registered users.

Given the availability of the bibliographic search through DTIC, the LAV project staff initiated searches immediately after contract award for the following areas:

- Armor Crew Training
- Armored Vehicle Training
- Gunnery Training Devices
- Transfer of Training

These searches were requested over the telephone to the DTIC Demand Services Branch at Cameron Station, Alexandria, Virginia. In requesting the searches, as was done in the MATRIS and DTIC Work Unit Searches, document citations that were CONFIDENTIAL or SECRET were to be excluded. Additionally, the searches were confined to the literature of the last 10 years.

APPENDIX C

CRITERIA FOR
TRAINING DEVICE GENERIC CATEGORIES

APPENDIX C
CRITERIA FOR TRAINING DEVICE GENERIC CATEGORIES

Actual Equipment with Substitute Firing Devices

- Training devices attached to actual equipment
- Subcaliber or simulated ammunition used

Dynamic Model

- External configuration similar to actual equipment
- Components - actual or simulated
- Visual and audio feedback
- Software modeled to replicate feedback

2 Dimensional/3 Dimensional Panel

- Flat panels
- Incorporates 2D representations with 3D characteristics
- Diagrams a pictorial representation of non-operational components
- Software modeled to replicate actual equipment feedback

Procedures Trainer

- Limited number of components
- Adaptable frame
- Components
 - high physical fidelity
 - mechanical moving parts
 - dynamic feedback from components as required

3 Dimensional Mockup

- External configuration similar to actual equipment
- Components
 - high physical fidelity
 - mechanical moving parts
 - no dynamic feedback

Other

- Devices not appropriately placed in one of the above generic categories

APPENDIX D

THREE DIMENSION (3D) MOCK-UP TRAINING DEVICE

ASSUMPTIONS AND COST CRITERIA RATIONALE

APPENDIX D

THREE DIMENSION (3D) MOCK-UP TRAINING DEVICE ASSUMPTIONS AND COST CRITERIA RATIONALE

- I. Requirement. The cost estimate for the acquisition of a 3D mock-up training device is based on the requirement to support training of mission oriented LAV turret tasks. These tasks were validated in the Task and Media analysis at the end of Phase I and are listed in Appendix J.
- II. Assumptions. The tasks considered in determining the cost estimates of a training device consisted of maintenance actions, ammo handling, immediate actions, and turret operations. Assumptions made prior to determining cost estimates are provided in the following lists, and are itemized under the category headings of Mechanical, Electrical, Operational, and Cost. This list is not intended to restrict or imply restrictions on additional or more elaborate features that may be desired during the development of the training device specifications. However, such changes could have an impact on the cost estimates.

A. Mechanical

- No special metals or other expensive materials are required.
- Hand turret controls, ammo equipment, sight bezel, and sight controls are medium fidelity. Fidelity of physical relationship of components to each other and to the student is high.
- Components requiring assembly and disassembly will be made of materials durable enough to withstand rough and incorrect handling expected in a training environment. Wood could be used extensively in the trainer.
- Turret does not move.
- Turret structure is open with a simple framework that defines the space available to trainees in the actual turret.
- Commander's and gunner's seats are included, but are not adjustable and are low in fidelity.
- Vehicle latches, hatches and vision blocks are not included.
- Turret hydraulic system mock-up is low fidelity (no fluids).
- Guns can be taken apart to the extent that hands-on tasks require.
- M242 gun barrel will be made of materials necessary to simulate the weight of the actual barrel.
- Relaxed tolerances (approximately 1/32") are also assumed since the guns would never fire.

- No audio simulation of the guns firing is included, however, either a mechanical click or electrical indication is included in the estimate.
- Boresighting cannot be simulated in the mock-up.
- Sight and gun sizes and shapes are accurate only to the degree necessary to prevent negative training. Components are realistic and durable where frequent handling is required. Remaining components could be wood or other inexpensive material. Some components may be omitted that are never used in training or are not a part of an assembly/disassembly task.
- The sight is not operational.
- No presentation other than the reticle image is visible through the sight, therefore, no engagement of target is possible.
- The hand control is rigid since neither the guns nor the turret move. Therefore, there is no control loading for simulated "feel" of turret controls.
- The ammo feeder is a mock-up, but allows the ammo to pass through realistically.
- Trainers must be housed indoors rather than in open air due to computer, CRT, and other electrical and electronic parts.
- All other mechanical properties of the turret are low fidelity or non-existent.

B. Electrical

- The simulation of the required functions and instructor interface is via a small floppy disk based micro-processor system with a CRT Keyboard (similar in complexity to INTEL 8080).
- The system software controls simulation and can be commanded by the instructor to insert faults, establish initial conditions, freeze the simulation, and display current status. A separate floppy disk could be used to file and store student records that are input from the keyboard.
- No radio or intercom equipment is included in cost estimates.
- Power Distribution Unit (PDU) and Control Display Unit (CDU) are of high physical fidelity.
- No interface of the sight electrically or electro-mechanically with any other components of the turret or guns is considered, other than for power-up and power-down procedures.

- Lights and indicators function realistically in response to correct switch, lever or adjustment movements; most are micro-switch or electrical/mechanical switch activated signals to the computer or direct to indicator lights. (Where computer is involved, sequence of actions is not monitored for correct procedure or for student testing purposes).
- No stabilization of turret, sight or gun, is included, however, mechanical/electrical devices sufficient to practice procedures are included.
- Minimal maintenance is anticipated to maintain trainer. Micro-processor based computer is maintained at the logic board level (swapping boards) and the only other components are lamps, switches, potentiometers, etc.
- All parts are commercial off-the-shelf units.

C. Operational

Student to instructor ratio is 4 or 5 to 1.

- Ten units consisting of one turret/gun trainer and one instructor station each are assumed.
- One instructor per trainer is estimated. The instructor monitors and scores student performance manually.
- Instructor interfaces with the trainer via the CRT keyboard and menu driven software commands. Instructor inserts faults, such as causing indicator lights not to work, or interruptions, like jamming through the use of solenoids.
- Training of gun assembly/disassembly can be done at a table or other location away from the turret after removal from the turret.

D. Cost

- No GFE is assumed in any cost estimate. Where appropriate, purchase of commercial versions of MIL-specification components is assumed to insure realism and eliminate design and development costs. Estimated material cost is based on off-the-shelf commercial grade units.
- The cost of the M242 Main Gun and M240 Coax Machine Gun 3D mock-up training units are based on the cost of the actual equipment.
- Materials overhead is estimated at 25% of the material cost. This amount covers handling, shipping, incoming inspection, and procurement cost.

- Labor costs are based on estimated hourly wages. The burdened rate of 100% of the estimated hourly wages represents a small or medium size business. This rate can be modified as required.

III. Cost Criteria Rationale. The rationale used in estimating the labor and materials cost of the 3D Mock-up is outlined in the following subparagraphs. It is a generic model and is not necessarily aligned with specific subparagraphs in the text of this report.

A. Development Costs

1. Front End Design Analysis

- Gather data for "target" device, including tech manuals, hardware specifications, functional parameters or capabilities, etc., of the actual equipment (may include video-taping of operational device, subject matter expert inputs, training scenarios, etc.).
- Generate System Design.
- Define which systems will be required to meet the training device requirements.
- Address hardware, software, and the hardware/software interface at the most general design level.
- Take into account, at this level, human factors, environmental requirements, training requirements, etc.

2. Cost Estimate Approach for Front End Design Analysis (1 above)

- Estimate Front End Design Analysis in man hours, based on the complexity of the "target" device, level of simulation (Operator Trainer, Maintenance Trainer, etc.) and number of functions (quantity) to be simulated.
- Consider the type of technical data required and expertise required for evaluation in all areas of design including electronics, programming, human factors, training, etc.
- Make judgments on the magnitude of work and expertise level required based on past experience of cost analysts.

3. Hardware Subsystem Design Requirement Analysis (Mechanical & Electrical) (based on the Front End Design Analysis)

- Define hardware required to generate the trainer to the subsystem level, including physical layout, computer(s) required, cooling requirements, module functional requirements, communication system/electronics, mass storage elements, etc.

4. Software Module Requirement Analysis (Top Level programming document) (based on the Front End Design Analysis)
 - Define function and parameters of all the software modules required by the simulation.
 - Define the Execute Programs and interaction of all modules.
5. Electrical Design, Mechanical Design (based on the Hardware Subsystem Design Requirement Analysis)
 - Generate detailed circuit design and mechanical design.
 - Generate blueprints, detailed layouts, parts lists, and materials lists.
 - Include engineering level documentation costs, design time, parts ordering, etc.
6. Software Design (based on the Software Module Requirement Analysis)
 - Include generation of module flow charts, coding, and assembly/link software functions.
7. Cost Estimate Approach Development Costs (3, 4, 5, and 6 above)
 - Formulate general design approach for the Hardware Subsystem, Software Module, Electrical, Mechanical, and Software Design requirements.
 - Identify significant design areas.
 - Estimate design time (man hours) for each.

8. Materials

Materials Cost Estimate is based on a realistic design approach. The cost of materials is usually based on actual cost data.

- Generate list of functional hardware units.
- Estimate cost of each unit by categorizing the components/materials and associated costs.
- Include cost of all materials required to build the trainer, i.e., cabinets, desks, computers, switches, wire, connectors, lamps, CRTs, etc., based on parts lists documents generated by the Electrical and Mechanical Design.

- Base cost estimates for components or subsystems on best commercial grade off-the-shelf equipment, meeting general training devices specification, MIL 23391. If actual equipment is utilized, its actual cost is used for the estimate.

9. Assembly & Fabrication

- Base man-hour cost estimates on number of components or subassemblies (estimated from materials) and complexity of their assembly.

10. System Integration

System Integration is the most difficult phase of any project to estimate.

- Include debugging, verification of operational stage of training device and successful completion of the Acceptance Test Procedure (ATP).
- Base estimate on quantity of software (modules), hardware functions and/or subsystems, and associated levels of complexity.

11. Reliability & Maintainability (man hours)

- Base cost estimate on MTBF of 400 hours and MTTR of 1 hour (minimum standard).
- Include design considerations as part of development costs.

Additional costs:

- Generate RAM plans and procedures.
- Test device for compliance.
- Generate reports.

12. Technical Data Package

Deliverable documentation:

- MIL-SPEC Level II Maintenance drawings.
- Vendor supplied documentation (such as Computer PCB, operating procedures, etc.).

Non-deliverable documentation (included in device cost estimate):

- Other production, engineering, or manufacturing documentation costs required by a contractor to build the training device.

B. Production Costs

1. Recurring Costs

- Materials, Assembly & Fabrication, and System Integration cost estimates.

2. Non-Recurring Costs

- Production Engineering cost estimates.

3. Production Cost Estimate Approach

This cost estimate is based on the recurring costs taken from their associated categories in the Development Cost estimate.

C. Final Cost Figure

Labor hours generated from the Development Estimates are categorized into current industry average hourly rates. Rates are burdened to allow for Corporate Overhead, G&A, and Profit. Burden rate for this estimate is 100%, which reflects a typical overhead of a medium to large size engineering company. Materials costs are increased 25% to allow for handling, procurement, and profit.

APPENDIX E

LAV TRAINING DEVICE SURVEY

APPENDIX E

LAV TRAINING DEVICE SURVEY

SOURCE OF IDENTIFICATION	
<u>LITERATURE SEARCH</u>	<u>PERSONAL CONTACT</u>

ACTUAL EQUIPMENT WITH SUBSTITUTE FIRING DEVICES

Mount, Subcaliber 5.56mm (Brewster Device) AVC NSN: Pending NSN: G920-01-117-8692 DA PAM 310-12	X	
Laser Gun Firing Trainer DVC 17-33 3A 102 NSN: 6920-01-067-1682 DA PAM 310-12	X	
M55 Laser Tank Gunnery Trnr DVC 17-56 NSN: 6920-00-686-4036 DA PAM 310-12	X	
Mount, Machine Gun 50 Cal Training Device (TELFARE) DVC 17-60, DA PAM 310-12 NSN: 6920-01-085-0608	X	
MILES: Mult. Intg. Laser Eng. System. Simulator System, Firing, Laser: M60A1/A3 Tanks DVC 07-56/7 M65 NSN: 1265-01-077-0680 DA PAM 310-12	X	
Stout Device (Tank Laser Target Device) DVC D-17-94 TRADOC PAM 71-9	X	
MK 20 On Board Gunnery Simulator - Honeywell		X
50 CAL Machine Gun	X	
7.62mm Subcaliber Gun	X	

SOURCE OF IDENTIFICATION	
<u>LITERATURE SEARCH</u>	<u>PERSONAL CONTACT</u>

ACTUAL EQUIPMENT WITH SUBSTITUTE FIRING DEVICES

SAAB BT41 Tank Gunnery Trainer - SAAB		X
SAAB BT52 TOW Simulator - SAAB		X
STAGS - Simulated Tank and Anti-Armor Gunnery System DVC 17-129	X	
Trainer, Launcher, Conduct of Fire (Improved) Device 10-124 NSN 6920-01-8558	X	
M16A1 Rifle	X	
DX 150 Tank Weapon Simulator - Giravion Dorand		X
DX 156 Tank Weapon Simulator - Giravion Dorand		X
DX 175 Tactical Training Simulator - Giravion Dorand		X

DYNAMIC MODEL

M48 Turret Familiarization and Communication Trainer DVC 17-07 NSN: 6920-01-67-1663 DA PAM 310-12	X
M48A1 Tank Turret Trainer DVC 17-20 NSN: 6920-01-067-1664 DA PAM 310-12	X
Trainer, Tank Gunnery, M30A1 105mm DVC 17-62 NSN: 6920-00-181-8785 DA PAM 310-12	X

SOURCE OF IDENTIFICATION	
<u>LITERATURE SEARCH</u>	<u>PERSONAL CONTACT</u>

DYNAMIC MODELS

TANK Turret Organizational
Maintenance Trainer (TTOMT)
Educational Computer Corporation

X

Conduct of Fire Trainer -
Link Miles

X

Armored Tank Conduct of Fire
Trainer - General Dynamics

X

Vital - Visual Simulators -
McDonnell Douglas

X

Tank Turret and Fire Control
Maintenance, M48A3
Trainer, Device 3A106
NSN 6920-C00-0945

X

Armored Vehicle Conduct of
Fire Trainer - General
Electric

X

Training Aids for Light Armored Vehicles
Generd Motors

X

2D/3D PANEL

No Training Devices Identified

PROCEDURES TRAINER

MK-60 Gunnery Trainer
Perceptronics

X

Burst On Target Tank
Gunnery Trainer
DVC 17-58
NSN: 6920-01-067-1666
DA PAM 310-12

X

Fire Control Combat
Simulator - General Dynamics

X

Tanga - Classroom Tank Gunnery
Trainer - Elbit Computers

X

SOURCE OF IDENTIFICATION	
<u>LITERATURE SEARCH</u>	<u>PERSONAL CONTACT</u>

PROCEDURES TRAINER

DX 201/EVIC Fire Control System - Giravion Dorand		X
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Combat Classroom Light Armored Vehicle - Sanders		X
---	--	---

Conduct of Fire Tank Gunnery Trainer DVC D 17-4	X	
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3-D MOCKUP

Device 3F85, M85 Machine Gun Mock-Up	X	
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Motorized Sectionalized .50 Coliber, M2 Machine Gun DVC 23-63/11D4A NSN: 6920-01-067-1684	X	
---	---	--

Armor Vehicle Models DVC T-17-103	X	
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OTHER

FAST: Fully Automated Scoring Target System MT-20 Moving Target System		X
--	--	---

TM-20H/ Tank-Vehicular Target Mechanism		X
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TM-20A Tank-Vehicular Target Mechanism		X
--	--	---

RETS: Remoted Target System		X
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TACWAR (terrain board) SEP 82 UCF "Insight"		X
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SOURCE OF IDENTIFICATION	
<u>LITERATURE SEARCH</u>	<u>PERSONAL CONTACT</u>

OTHER

Main Tank Gun Weapon's
Effect Signature Simulator
(WESS) or 17-61
NSN: 6920-01
DA PAM 310-12-067-1667

X

Visual Modification Kits
(VISMOD)
DVC T-30-20

X

Small Scale Stationary
Tank Ranges
DVC D-17-85

X

Automatic Tank Target
System (ATTS)
DA PAM 310-12
DVC 17-63

X

Tanker Game
DVC 7-17-80

X

I-COFT Trainer Target
DVC 17-125
NSN: 6920-01-048-8557

X

Mini Tank Detection System

X

Training Set Fire
Observation (TSFO) Invertron Simulated Systems Limited

X

SPIRITUS II - Fowler Asso.

X

APPENDIX F

LAV LITERATURE SEARCH BIBLIOGRAPHY

APPENDIX F
LAV LITERATURE SEARCH BIBLIOGRAPHY

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ACTUAL EQUIPMENT WITH SUBSTITUTE FIRING DEVICE

APPENDIX G

**TRAINING EFFECTIVENESS STUDIES ON TRAINING DEVICES
WITH POTENTIAL APPLICABILITY TO THE LAV**

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TRAINING EFFECTIVENESS STUDIES ON TRAINING DEVICES WITH POTENTIAL APPLICABILITY TO THE LAV

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APPENDIX H

**LAV TRAINING DEVICES
ELIMINATED FROM FURTHER STUDY**

APPENDIX H

LAV TRAINING DEVICES ELIMINATED FROM FURTHER STUDY

ACTUAL EQUIPMENT WITH SUBSTITUTE FIRING DEVICE

1. Trainer, Launcher, Conduct of Fire (Improved)
Device 17-124
NSN 6920-01-8558

Purpose: This device simulates the firing of the SHILLELAGH Missile. It will permit M60A2 and M551 armored vehicle tank gunners to be trained in missile gunnery. In conjunction with subcaliber devices, this device provides comprehensive gunnery training capability for the M60A2 and M551.

Description: The major components of the COFT-I include a Control Display Unit (CDU), Optical Simulation Unit (OSU), Launch Recoil Simulator (LRS), power cable and a Passive Target (DVC 17-125). Their principle functions are:

- a. CDU: Provides data on gunnery proficiency. A visual display device in the CDU enables the instructor to monitor tracking while a 12 block matrix indicates errors being committed by the student. A percentage score based on the gunner's ability to remain on target while tracking and to obtain a target is provided.
- b. OSU: This unit mounts in front of the gunner's telescope port, optically superimposes a missile tracer image in the gunner's field-of-view, and simulates smoke obscuration and missile detonation.
- c. LRS: This unit simulates the effects of launcher recoil. A brow pad connected to the gunner's telescope moves rearward when the missile is launched.

Rationale

- for Rejection:**
1. COFT-I is not applicable to the majority of HOT Gunnery Skills Tasks. (LAV does not currently have missile firing capabilities).
 2. Level of fidelity of the device is not sufficient for LAV training requirements.

2. Simulated Tank and Anti-Armor Gunnery System (STAGS)
Device 17-129

Purpose: To enhance gunner's skill in engaging armored targets using the DRAGON anti-armor weapon.

Manufacturer: Advanced Systems Concepts Laboratory. Code N-731. Trainer is in prototype stage of development.

Description: STAGS is comprised of three major subsystems; the student station, instructor station, and moving target/trainer table. The student station will consist of a modified DRAGON weapon. The student will fire at a scaled model of an enemy tank on a terrain table. When fired the trainee will view the missile in flight and experience recoil, weight shift, smoke obscuration, etc.

The instructor station will have the capability of monitoring the trainee's sight picture, display aiming errors versus time in real-time, graphically display aiming errors in azimuth and elevation, and determine target hit or miss distances.

The moving target and terrain table will present a specific battlefield scene with one scaled moving, threat armored tank target.

Rationale

for Rejection: 1. LAV does not employ hand held wire-guided anti-tank weapons. STAGS is not applicable for the HOT task identified for LAV Gunnery skills.

3. **Laser Gun Firing Trainer**
Device 17-33
NSN 6920-01-067-1682

Purpose: To train gunnery procedures on the M48 Series Tanks, M60 Series Tanks, and the M551 Armored Reconnaissance/Airborn Assault Vehicle. Specifically to train crewmen on the proper techniques of:

- a. Laying sights on a target
- b. Tracking a target
- c. Firing the gun
- d. Visually adjusting the lay of the weapon on a target

Manufacturer: Not generally available for issue (limited production).

Description: The device consists of the following: (1) a laser-type simulator, (2) a power supply, (3) a blower assembly, (4) a blower hose assembly, (5) targets, (6) required interconnecting cables, and (7) a carrying case.

The laser simulator is installed in the vehicle's M73 machine gun mount. The simulator provides a single, bright burst of intense red light, which appears through the vehicle optics on the target as a momentary red spot. Crewman is thus able to determine how well he is laying his gun sights and tracking the target.

Rationale

for Rejection: 1. This device has been replaced by DVC 17-56, the M55 Laser. The M55 is much less bulky without all the extra components that DVC 17-33 has. The M55 is also capable of being mounted on the Brewster device, DVC 17-33 is not. Brewster device is being considered as a training device option.

4. Multiple Integrated Laser Engagement System (MILES) Simulator System, Firing Laser: M60A1/A3 Tanks
Device 07-56/7M65
NSN 1265-01-007-0680

Purpose: To provide two sided, real-time tactical weapon simulation engagement.

Manufacturer: Available through local TASCs or DISCOMs

Description: The device consists of a laser transmitter mounted on the barrel of the M85 Machinegun, two laser transmitters (one for the 105mm gun and one for the coaxial machinegun) mounted in the breech of the main gun; detector belt segments mounted around the tank turret; a vehicle kill indicator mounted on top of the vehicle, and man worn detector assemblies. When the detector belts located on the vehicle are activated, the strobe mounted on the vehicle will react differently depending if the vehicle has been killed, hit, or suffered a near miss.

Rationale

for Rejection: 1. MILES is designed for two sided engagement exercises focusing on tactics and not gunnery/turret operator maintenance skills.

2. It is assumed that the Marine Corps is already committed to MILES for engagement training and will acquire the system for LAV unit use.

5. SAAB BT 52T Anti-Tank Guided Missile Simulator

Purpose: To train TOW Missile gunnery skills.

Manufacturer: SAAB-SCANIA

Description: A laser unit is placed inside the normal TOW sight from which the missile guidance IR sensor is removed. A control unit with display and printer is connected to the system. A dummy with same weight and appearance replaces the missile. Blast and recoil is simulated by a pyrotechnic unit. During missile firing, flight deviation is continuously recorded and a diagram of the entire flight is printed out. The TOW simulator can be fired at any moving or stationary target that is fitted with a laser reflector.

Rationale

for Rejection: The device was originally rejected because the LAV-25 does not mount TOW weapon systems. However, since one MRV variant of the LAV does mount the TOW, the SAAB device may warrant further investigation in the future.

DYNAMIC MODEL

6. M48 Tank Turret Familiarization and Communications Trainer

DVC 17-07

NSN 6920-01-067-1663

Purpose: To support basic and advanced training of task crewmen in coordinated tank operation, gunnery, and communication.

Manufacturer: Not generally available for issue (limited production).

Description: The device is a skeletonized version of a full-scale M48 Tank turret capable of rotating 360°. The turret is installed with the following equipment: (1) synthetic 90mm gun with an operable breech permitting assembly, loading and unloading; (2) a combination mount; (3) a stereo range finder, periscope, telescope, and communications equipment; and (4) turret and fire control equipment.

Rationale

for Rejection: The device is out of date and does not meet the fidelity requirements of the LAV.

7. M48A1 Tank Turret Trainer
DVC 17-20
NSN 6920-01-067-1664

Purpose: To train basic and advanced crewmen on the following: (1) mounted action drill; (2) operation of cupola, turret and combination gun mount; (3) service of the main gun; (4) conduct of fire for day firing of the main armament; (5) live machine gun firing exercise; (6) RTO procedures; and (7) installation and maintenance of the AN/GRC series tank radio.

Manufacturer: Not generally available for issue.

Description: The trainer is self-contained and simulates the operation and functions of the M48A1 Tank turret. Functional equipment and controls are located in their correct relative position. The trainer consists of a turret shell mounted on a supporting base. The turret can be traversed 360° in either direction.

Rationale

for Rejection: Device is out of date and does not meet the fidelity requirements of the LAV.

8. Tank Turret and Fire Control Maintenance, M48A3
DVC 3A106
Local Stock No: 6920-C00-0945

Purpose: To teach tank turret maintenance crews in preventive, organizational, and some field maintenance.

Manufacturer: Contact Naval Training Equipment Center, Orlando, FL.

Description: The device is an Army M20 Tank Turret Trainer rebuilt to the M48A3 Tank configuration. Sides are open to allow for unobstructed viewing of the turret interior. The turret is equipped with the same 90mm gun tube, breech block, and gun mount as the M48A3.

Rationale

for Rejection: Device is out of date and does not meet the fidelity requirements of the LAV.

9. Training Aids for Light Armored Vehicles

Purpose: To train crewmen in 2nd, 3rd and 4th echelon maintenance of the LAV turret, electrical, fuel and engine system, etc.

Manufacturer: General Motors

Description: Training boards of the actual equipment or dynamic models enable the student to receive hands-on training in a variety of maintenance tasks. The training boards can be housed in a truck allowing for portability and increased fidelity.

Rationale

for Rejection: Device does not train a majority of the HOT manipulative tasks identified in the task analysis.

10. Vital Visual Simulation System

Purpose: This device is designed to simulate landing, take-off and all flying requirements a pilot must engage in.

Manufacturer: McDonnell Douglas

Description: Vital Visual Simulation System is an airline cockpit trainer that realistically simulates a large variety of flying environments including snow, water, waves, ice, rain, fog, clouds, air/ground traffic, etc. It has a full color range, high resolution, beam penetration, shadow mask, etc.

Rationale

for Rejection: Vital is a cockpit trainer that specializes in aircraft training. No similar system has been built by McDonnell Douglas for tank/gunnery training.

2 DIMENSIONAL/3 DIMENSIONAL PANEL

No Training Devices Identified

PROCEDURES TRAINER

11. Conduct of Fire Tank Gunnery Trainer (Green Hornet)
Device D-17-4

Purpose: This device is used to enhance training of initial main gun lay and of adjustment fire using the burst on target method.

Manufacturer: Local TASC.

Description: The device consists of a wooden frame approximately 27" x 27" containing a firing switch, battery box, and a movable metal plate. Superimposed on the metal plate is a clear plastic window and a transparent acetate sight reticle. The reticle can be moved on the window or interchanged with different recticle patterns. A movable target scene is mounted behind the frame. A small light in the rear of the device indicates a target hit.

Rationale

- for Rejection:**
1. The majority of HOT gunnery tasks cannot be trained on the Conduct of Fire Tank Gunnery Trainer. Only Burst-on Target adjustment of fire can be trained. Complicated target engagement can not be trained (e.g., moving LAV, moving target).
 2. The device is out of date and does not meet the fidelity requirements of the LAV.

12. Burst-On Target Tank Gunnery Trainer
Device 17-58
NSN 6920-01-067-1666

Purpose: To teach burst-on target method of tank gunnery adjustment. The device is a table top trainer to be used in the classroom.

Manufacturer: Not generally available for issue. Commercially manufactured.

Description: This device has a simulated tank turret control and a gunner's sight. Target and reticle move with respect to each other when the controls are activated. 35mm color slides depict 80 different target scenes. If the student is on target, a flash of laser light simulates a hit. The instructor has independent control of the burst position and is able to view the student's scene on a separate screen.

Rationale

- for Rejection:**
1. The majority of HOT gunnery tasks can not be trained. Complicated target engagements are not possible.
 2. The device is out of date and does not meet the fidelity requirements of the LAV.

3-DIMENSIONAL MOCK-UP

13. **Armored Vehicle Models**
 Device 17-103

Purpose: To aid in recognition of U.S. and foreign nation armored vehicles.

Manufacturer: Available at local TASC.

Description: The vehicles are plastic, three dimensional, 1/60th scale models of the following 11 armored vehicles: BMP, ZSU-23-4, T-62, BRDM, BRDM-2, T-55, BTR-60PB, PT-76, M551, M113A1, and M60A1.

Rationale

- for Rejection:**
1. This training aid is not applicable to the HOT task categories.

OTHER

14. **Visual Modification Kits (VISMOK)**
 Device 30-20

Purpose: Used for realistic force on force tactical training at National Training Center (NTC). Also used for specific training in vehicle recognition, target acquisition, ranging, and intelligence play.

Manufacturer: Available at NTC TASC only (limited production).

Description: Full scale fiberglass mock-ups of Opposing Force vehicles which are for use only at the NTC, Fort Irwin, CA. There are five mock-ups: T-72, 122SP, ZSU, BMP and BRDM-2.

Rationale

for Rejection: 1. Not applicable to any of the HOT task categories.

15. TACWAR

Purpose: To provide small unit leaders with opportunities to develop and practice the tactical and leadership skills they will need in operational situations. TACWAR is designed to teach combat knowledge and skills in a competitive, safe environment at minimal cost and at no safety risk to the players.

Manufacturer: Designed by University of Central Florida. Prototype units are currently being evaluated prior to delivery to USMC.

Description: The device consists of a geo-morphic terrain board with interchangeable parts. The game is played on a series of moves that parallel combat engagement except for time compression.

Rationale

for Rejection: The game teaches tactics and does not enhance the learning of any of the HOT tasks categories.

16. Tanker Game

Purpose: To be used by small unit commanders to teach tank crews the basic knowledge required for tank crew proficiency and success in combat.

Manufacturer: Available at local TASC.

Description: Each player answers related subject questions that are written on cards. Successfully answering questions allows the player to move model tanks on a terrain board.

Rationale

for Rejection: The device does not teach a majority of HOT tasks and some emphasis is placed on tank tactics, a subject that is beyond the scope of this study.

17. Simulator, Tank Gunfire (WESS)
DVC 17-61
NSN 6920-01-067-1667

Purpose: Designed to simulate the effects of firing a tank or anti-tank gun in training operations. Noise, flash, and smoke simulating the firing of the gun are emitted when activated by the gunner.

Manufacturer: Available at local TASC

Description: The simulator body can be loaded with nine pyro charges and is mounted on 90-152mm gun barrels. Electrical circuit is connected from the pyro charge to the firing device inside the tank.

Rationale

for Rejection: This device is not applicable to a majority of any of the HOT tasks.

18. Mini Tank Hit Detection System
Technical Note 5-81

Purpose: This device is designed to accept caliber .50 spotter rifle fire, detect those hits and transmit the data via the radio/intercom system to both the crew of the vehicle and control station.

Manufacturer: U.S. Army Human Engineering Laboratory - prototype stage.

Description: Piezoelectric accelerators are located on exterior of the vehicle and detect when the vehicle has been hit with caliber .50 tracer ammunition. The vehicle is based on M114 hull and is scaled to 0.6. in silhouette and 0.7 in width.

Rationale

for Rejection: This device is used to notify crew members that their vehicle has been hit. It does not enhance the learning of any of the HOT categories.

19. Spirities II

Purpose: To enhance learning procedures, checklists, etc., by combining sight, hearing and touch.

Manufacturer: Fowler Associates, Inc.

Description: The device is an audio visual system utilizing a touch screen to respond to prompting by programmed instruction. Programmed instructions are presented on one or two touch screens accompanied by random access audio cassette tapes.

Rationale

for Rejection: No hands-on training actually occurs. The fidelity of the device does not meet the LAV requisite level.

20. Training Set-Fire Observation (TSFO)

Purpose: To train artillery or mortar forward observers in quick identification of a target, determination of target position, and call for fire on a target.

Manufacturer: Invertron Simulated Systems Limited.

Description: The device consists of a control console, projection system, target control box, and communication boxes (optional). The operator controls the TSFO via a CRT unit and keyboard attached to the computer which is part of the control console. Slides of actual terrain are projected onto a screen 1.5 meters by 6 meters. Students observe the target area under the same visual conditions as from the actual observation point. The student, using binoculars, determines location of the target and passes this information to the operator.

Rationale

for Rejection: The device does not train a majority of the HOT tasks identified for gunnery skills.

Targets/ranges were eliminated from the original training device list since their investigation is outside the scope of this study. However, if a device is recommended in Section III that requires a specific type of target or range (e.g., subcaliber devices), then that target/range will be addressed when discussing the training device. Target information collected as part of the existing training device research is provided herein for information.

21. Fully Automated Scoring Target System (FAST): MT-20 Moving Target System

Purpose: To provide a target that realistically simulates tank movement.

Manufacturer: Polytronic ABA, Inc.

Description: This device simulates tank movement by traveling up to 40 mph on a concrete monorail. It can move either forward or backward and can disappear and reappear at random. A hit/kill feature can accurately discriminate between near miss, wind, debris, etc., while counting hits at a rate of up to 2400 rounds per minute. The device can mount laser, thermal, pop-up and full scale targets. The MT-20 is a full scale target system.

22. TM-20H/Tank-Vehicular Target Mechanism

Purpose: To provide realistic pop-up tank target designed to reduce training costs and save time.

Manufacturer: Polytronic ABA, Inc.

Description: This system can mount laser, infrared, soft impact and thermal targets. The device can be directed via control consoles on a fixed range or radio control on a portable range. The device can determine if 1st round has recorded a hit or kill and thus can eliminate need for 2nd round engagement. The target mechanism is driven by a hydraulic ram attached to a pivot arm which can produce 3,500 foot pounds of torque.

23. TM-20A Tank-Vehicular Target Mechanism

Purpose: To provide realistic pop-up tank targets designed to reduce training costs and save time.

Manufacturer: Polytronic ABA, Inc.

Description: This system can mount laser, infrared, soft impact and thermal targets. The device can be directed by control consoles on a fixed range or by radio control on a portable range. The target mechanism is an electromechanical device with control electronics and a drive motor that produces 4,800 foot pounds of torque.

24. RETS: Remoted Target System

Purpose: To provide realistic tank gunnery and combined arms targets.

Manufacturer: Sperry

Description: Preplanned battle scenarios are controlled by computer in which 1/5 scale or full scale tank targets pop-up and move. Scaled infantry targets also pop-up and move. RETS is currently in use at Fort Benning.

25. Automatic Tank Target System (ATTS)

DVC 17-63

NSN 6920-01-084-6951

Purpose: To support training of tank gunnery personnel in identifying and firing on hostile vehicles and personnel.

Manufacturer: Not generally available for issue (limited production); see PM TRADE.

Description: Device is a portable pop-up tank target that will automatically drop to down position when hit sensor assembly is activated.

26. Small Scale Stationary Tank Ranges, 1/20, 1/35, 1/60 scale

Purpose: Allow units to realistically simulate main gun tank firing using subcaliber or substitute firing devices (e.g., M55 laser) resulting in substantial ammunition cost savings.

Manufacturer: Local TASC

Description: Dimensions of range is dependent upon impact area available and caliber of device used. See FM 17-12-7 for specific dimension of various ranges with various caliber devices.

27. Trainer, Target, Conduct of Fire (Improved)
DVC 17-125
NSN 6920-01-048-8557

Purpose: To function as a target for use in conjunction with M62 COFT-I Trainer (DVC 17-124).

Manufacturer: Not generally available for issue (limited production).

Description: Target is passive and contains a series of lightweight reflectors capable of receiving a transmitted beam of infrared light from the Optical Simulation Unit of DVC 17-124 and reflecting it back to the tracking vehicle.

APPENDIX I

**TRAINING DEVICES SELECTED FOR INCLUSION IN
TRAINING DEVICE OPTIONS**

Separated By Category:

Actual Equipment With Substitute Firing Device

Dynamic Model

Procedures Trainer

3D Mock-up

MOUNT, SUBCALIBER 5.56MM (BREWSTER DEVICE)

DVC 17-59

NSN Pending



DVC NO. 17-59

Training Category/Level Utilized:
Armor/Level 2

Logistic Responsible Command, Service, or Agency:
ARRCOM

Source and Method of Obtaining:
Available through local TASCs.

Purpose of Trainer:

This is a mounting device which permits use of the M16 Rifle or M55 Laser for subcaliber firing at reduced range. This provides a savings in main gun ammunition and allows firing to be done where space is at a premium. It is used in conjunction with the Scaled Range

Target System. The specific training requirements supported are shown following the descriptive data.

Functional Description:

The device consists of the following: (1) Universal mounting plate assembly; (2) a wiring harness; (3) system specific brackets for the M48/60 series, M60A2 Tanks and M551 ARAAV to mount the device on these systems; (4) a front mount subassembly attached to the universal mounting plate assembly which allows the mounting of the M16A1 Rifle and the M55 Laser Gunnery Trainer; (5) solenoid.

The device brackets are mounted so the firing device is positioned as close to the primary sight as possible to prevent parallax. The device employs the M55 Laser

DA Pam 310-12

Trainer, the M16A1 Rifle with 5.56mm ammunition and the M16A1 Rifle modified with the rimfire adapter to fire .22 caliber ammunition.

The device is wired to the control firing circuit and is fired by the gunner's firing trigger.

Physical Information:

M60/48 Series: 32" x 21" x 10"

M60A2: 32" x 10" x 8"

M551: 32" x 6" x 8"

Equipment Required, Not Supplied:

M55 Laser (DVC 17-56) or M16A1 Rifle with Rimfire Adapter (DVC 07-55)

Special Installation Requirements:

None

Power Requirements:

24 vdc vehicle voltage

Applicable Publications:

TM 9-6920-441-12&P

Reference Publications:

FM 17-12 with supplements

Training Requirements Supported:

MOSC 19E, 19G, and 19J

SM 171-121 Task

1008

SM 171-127 Tasks

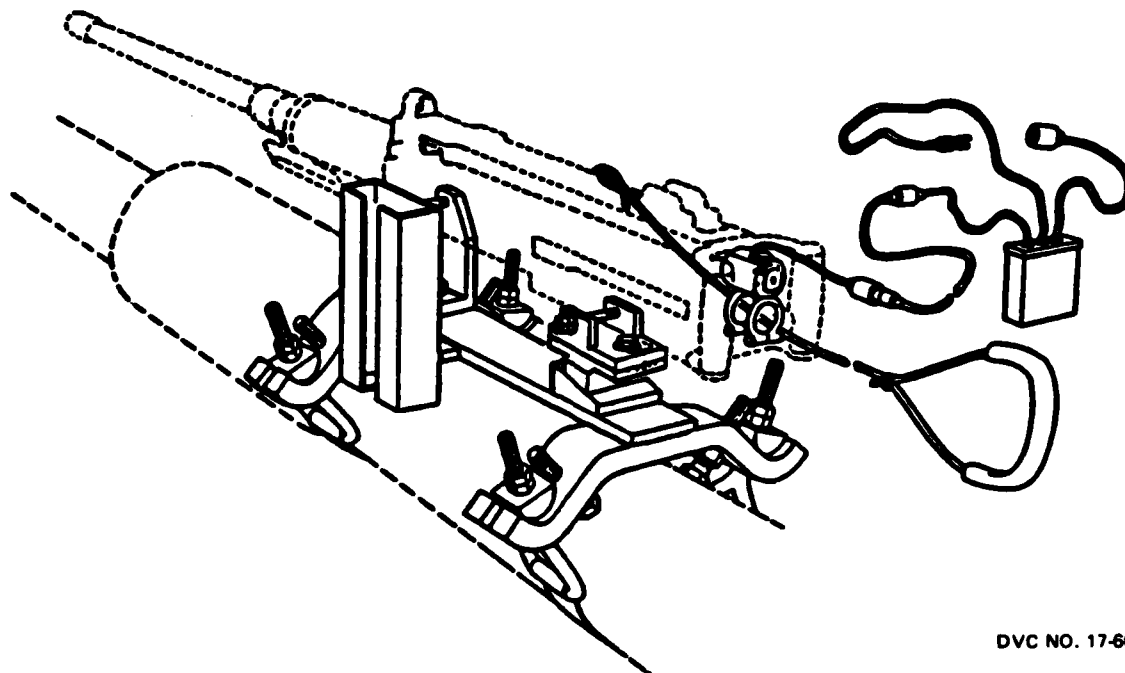
1009	1013	1511	1755
1010	1395	1515	1759
1011	1397	1555	1781
1012	1510		

SM 171-139 Tasks

1009 1030

MOUNT, MACHINEGUN: .50 CALIBER TRAINING DEVICE (TELFARE)DVC 17-60
M179

NSN Pending



DVC NO. 17-60

Training Category/Level Utilized:
Armor/Level 2

Logistic Responsible Command, Service, or Agency:
ARRCOM

Source and Method of Obtaining:
Available through local TASCs.

Purpose of Trainer:

This is a mounting device which permits substitution of the M2 .50 Caliber Machinegun for the M60 Series Tank 105mm gun and the SHILLELAGH 152mm gun/launcher. This device is used for sub-caliber firing at full scale ranges. It permits the more realistic full scale gunnery tables to be fired in preparation for qualification without the expense of 105mm ammunition. The specific training requirements supported are shown following the descriptive data.

Functional Description:

The device consists of the following: (1) Mount assembly; (2) traversing and elevating mechanism; (3) strap assembly; (4) pull cable assembly; (5) solenoid, (6) controller assembly (single shot device); (7) wiring harness assembly. The device is capable of mounting on the 90mm, 105mm, and 152mm gun tubes and the bore evacuator of the 90mm and 105mm guns. The device mounts the M2 Heavy Barrel Machinegun and fires M20 or M17 ammunition. The device is wired to the control firing circuit and is fired by the gunner's firing trigger. The single shot device insures that only one round is fired each time the trigger is pulled. The pull cable assembly provides the loader with the capability of charging the gun from his hatch.

Physical Information:

20" x 17" x 12"; 74 lb

DA Pam 310-12

Equipment Required, Not Supplied:
M2 Heavy Barrel Machinegun

MOSC 19E, 19G, and 19J

Special Installation Requirements:
None

SM 171-121 Task

1008

Power Requirements:
24 vdc vehicle voltage

SM 171-127 Tasks

Applicable Publications:
TM 9-6920-374-12&P

1009	1381	1515	1553
1010	1389	1516	1554
1011	1392	1521	1555
1012	1395	1539	1759
1013	1397	1544	1778
1016	1510	1549	1781
1018	1511	1552	

Training Requirements Supported:

SM 171-139 Tasks

ARTEP 17-55 Task

3-32

1009	1017	1027	1045
1016	1026	1030	

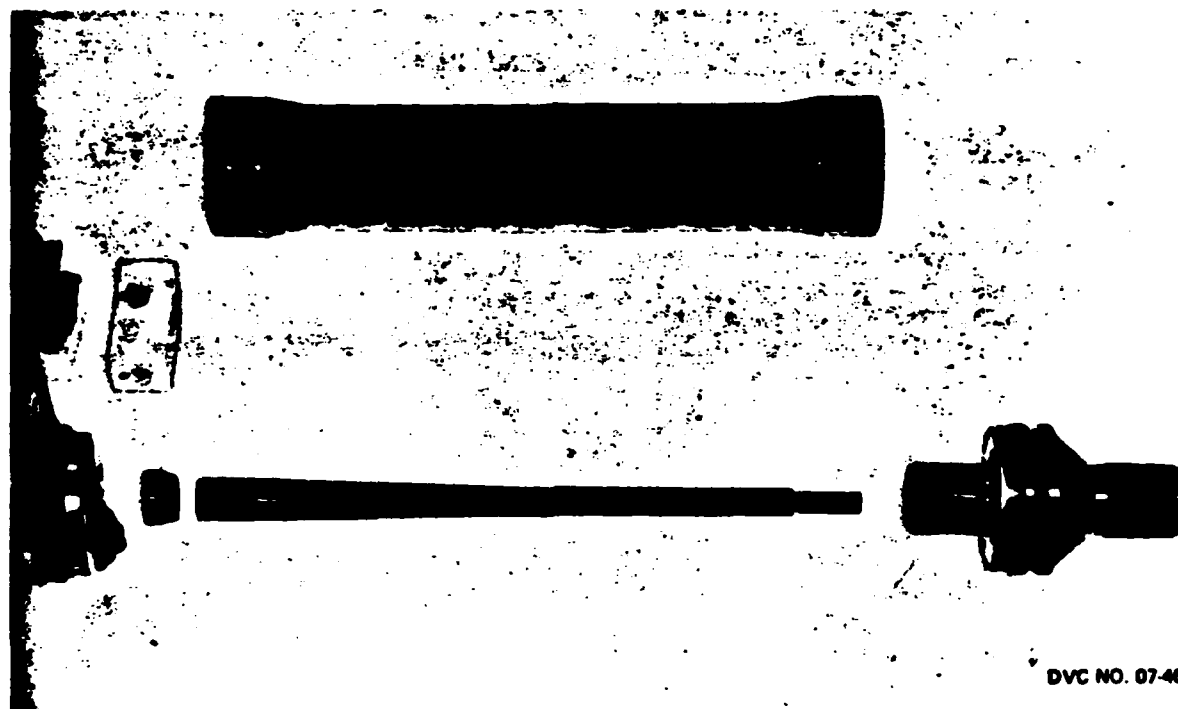
ARTEP 71-2 Task

6-20

7.62MM SUBCALIBER GUN

DVC 07-46
M149A1

NSN 1005-00-702-8159



DVC NO. 07-46

Training Category/Level Utilized:
Infantry/Level 3

Logistic Responsible Command, Service, or Agency:
ARRCOM

Source and Method of Obtaining:
Generally available through the supply system as authorized by AR 310-49.

Purpose of Trainer:
The device provides more extensive training in the laying and firing of the M67, 90mm Recoilless Rifle than would be permissible with larger ammunition. The specific training requirements supported are shown following the descriptive data.

Functional Description:

The trainer consists mainly of a long cylindrical sleeve, barrel, bushing with integral hinge, locknut, housing firing pin, and attaching hardware.

The subcaliber gun is positioned in the barrel of the Recoilless Rifle and is fired with the firing mechanism of the 90mm Recoilless Rifle. The subcaliber gun utilizes a case blow-out principle through six equally spaced holes in the chamber-shoulder section of the barrel. This training device has a comparable trajectory with the major caliber weapon up to 400 meters.

Physical Information:

Overall length of barrel: 16"
Weight of complete gun: 11 lb

DA Pam 310-12

Equipment Required, Not Supplied:

Ammunition: 7.62mm M62 Tracer, M80
Ball, or M61 Armor Piercing

Special Installation Requirements:

None

Power Requirements:

None

Applicable Publications:

TM 9-1015-223 Series

Reference Publications:

FM 23-11

Training Requirements Supported:

ARTEP Tasks

6-32-A	6-32-C	6-32-E	6-32-F
6-32-B	6-32-D		

MOSC 11H

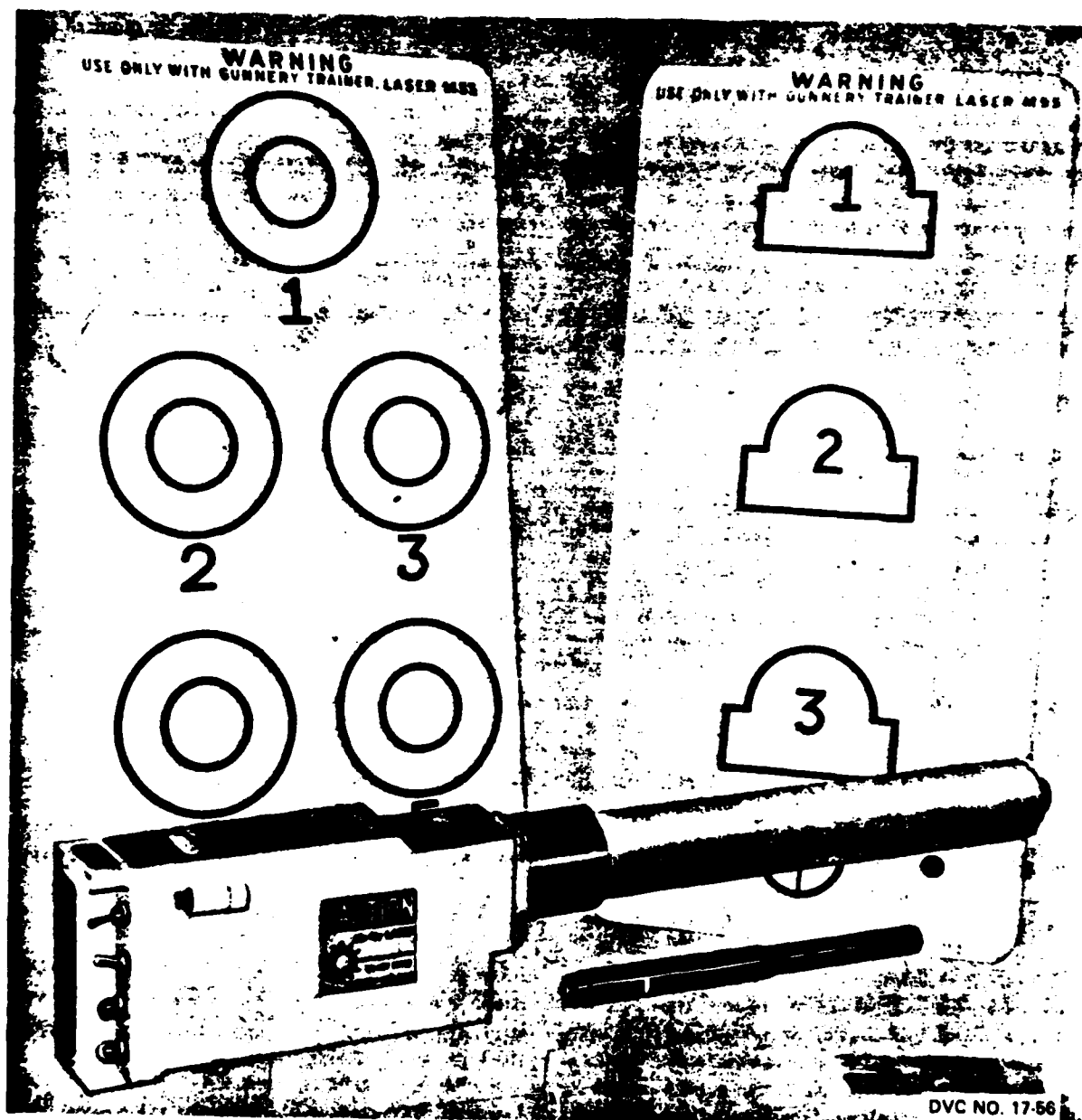
SM 071-319 Tasks

3155

LASER TANK GUNNERY TRAINER

DVC 17-56
M55

NSN 6920-00-689-4036



Training Category/Level Utilized:
Armor/Level 1

Logistic Responsible Command, Service, or Agency:
ARRCOM

Source and Method of Obtaining:

Not generally available for issue (limited production).

Purpose of Trainer:

For use on the target range to train crewmen of M48 Series Tanks, M60 Series Tanks, and the M551 Armored Reconnaissance/Airborne Assault Vehicle in gunnery procedures. Specifically, to train crewmen on the proper techniques of:

- a. Laying sights on a target
- b. Tracking a target
- c. Firing the gun
- d. Visually adjusting the lay of the weapon on a target

Functional Description:

The device consists of the following: (1) barrel extension, (2) trainer, laser gunnery, (3) TM 9-6920-357-10, and (4) carrying case.

The trainer is installed in the vehicle's M73/M219 machinegun mount. Each time the main weapon firing circuit in the vehicle is activated, the simulator provides a single, bright burst of intense red light, visible through vehicle optics as a momentary red spot on the target. This enables the crewman to accurately determine how well he is laying his gunsights and tracking the target. In addition, a supervising scorer can observe how accurately and proficiently the crewman is operating the vehicle's main weapon system.

The simulator optics can be focused to adjust for a spot 5/8" in diameter at a range of 200 feet. After installation, the vehicle optics must be boresighted to the laser beam before the simulator can be used. The laser trainer is operated from vehicle power.

In addition to the above components three types of targets are provided:

- a. A zeroing silhouette target with five circles 4 inches in diameter with crosslines in each circle.
- b. An initial lay target with five bull's eyes consisting of concentric circles 4 inches and 8 inches in diameter.

c. A moving target with 15 identical geometric patterns 6 inches high and 8 inches wide, separated by 12 inches on either side and 7 inches top and bottom. A number 2 inches high is inscribed in the center of each pattern. The moving target is not provided with a means for moving it, but must be mounted on a device which provides the motion.

d. Special retroreflective targets are required and lead must be introduced into the gunner's sights to engage moving targets.

e. When mounted in the coaxial position, parrallax affects accuracy and targets must be emplaced at the range at which the M55 was zeroed.

f. When used with a Brewster device, parrallax is reduced.

Physical Information:

12" x 9" x 35"; 36 lb

Equipment Required, Not Supplied:

None

Special Installation Requirements:

None

Power Requirements:

24 vdc

Applicable Publications:

TM 9-6920-357-10

Reference Publications:

FM 17-12

Training Requirements Supported:

FM 17-19E1/2, FM 17-19E3, FM 17-19F1/2, FM 17-19G1/2, FM 17-19J1/2, and FM 17-19J3.

SM 171-127 Tasks

1009	1013	1397	1554
1010	1014	1544	1555
1011	1389	1552	1781
1012	1395		

SM 171-139 Task

1017

4-2. STOUT DEVICE

a. General. This device simulates main gun fire. The crew can use it to perform all duties necessary to fire the main gun and adjust fire, except burst-on-target method of adjustment. The device is excellent for practicing range-card engagements. It consists of the M55 laser trainer, a magnetic plywood board, 1/2-inch targets and corresponding 1/2- or full-scale targets.

For more information on the Stout device, see DATA #17-94 and TRADOC Pamphlet 71-9, "Catalog of TASC Training Devices," DVC-D 17-94.

b. Placing the Stout Device in Operation.

(1) Mount the M55 laser trainer in the coax position in the tank. Place a 2 x 6-foot magnetic board at the muzzle of the main gun and emplace 1/2- or full-scale targets at ranges of 500-4,400m and within a range fan 400m wide. Place the rangefinder in operation. Aim the primary sight at the center of the range fan area. Move the magnetic board about 2 inches in front of the main gun, and center it on the muzzle.

(2) The tank commander selects a 1/2- or full-scale target down range and identifies it to the gunner. He then determines the proper ammunition and indexes the range to the target. The gunner indexes the ammunition, makes sure the computer is on, and makes a final precise lay on the distant target as though he were going to fire. The gunner then depresses the electrical trigger with the laser switch in the continuous mode. The loader, using laser safety goggles, centers the 1/2-inch target on the magnetic board at the location of the laser hit. The remaining targets are arranged on the magnetic board similarly.

c. Using the Stout Device.

(1) The M55 laser is connected to the main gun electrical wiring harness at the safety. This ensures the safety is in the SAFE position while the main gun is loaded with a dummy round of ammunition. The range scale window may be covered to prevent indexing range.

(2) The tank commander selects a target downrange, lays the gun for direction, and issues the proper fire command.

(3) The gunner identifies the target, turns on the main gun switch, and indexes the announced ammunition into the computer.

(4) The loader moves the main gun safety to SAFE, loads a dummy round, clears the path of recoil, moves the safety to FIRE, and announces "UP."

(5) The tank commander ranges on the target.

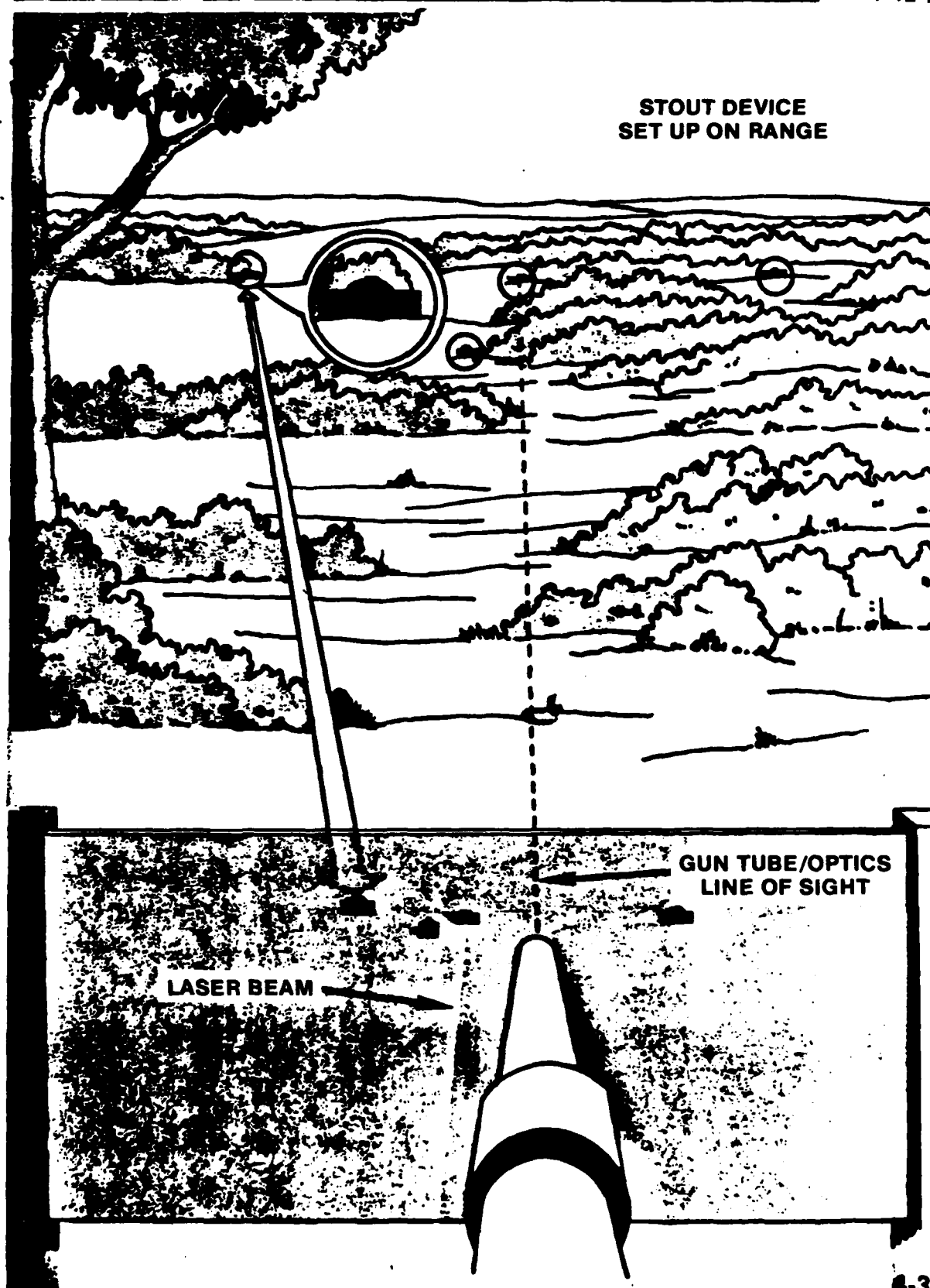
(6) The gunner makes a final precise lay. When the tank commander is in position to sense and adjust the fire, he issues the command "FIRE."

(7) The gunner announces "ON THE WAY" and fires. If the crew performs its duties properly, the laser beam will strike the corresponding target on the magnetic board at the identical point of aim as that of the main gun on the distant target.

(8) Since the gunner can't sense the laser beam, he announces "LOST." The tank commander uses an alternate method to adjust fire.

(9) To practice the various methods of adjustment, the tank commander may deliberately cause a first-round miss by indexing an incorrect range into the rangefinder or announcing an incorrect range in the fire command.

**STOUT DEVICE
SET UP ON RANGE**



GIRAVIONS DORAND Industries



DX175
SIMULATEUR
DE TIR DE COMBAT
TACTICAL
TRAINING SIMULATOR

GENERALITES

Le simulateur de Tir de Combat DX 175 est un système permettant l'entraînement tactique dans les conditions de combat réelles. Il permet de simuler toutes les formes de combat : sol-sol, sol-air, air-sol, air-air et permet une très grande variété de thèmes tactiques et de moyens d'engagements.

Le simulateur de Tir de Combat DX 175 est un système permettant l'entraînement tactique dans les conditions de combat réelles. Il permet de simuler toutes les formes de combat : sol-sol, sol-air, air-sol, air-air et permet une très grande variété de thèmes tactiques et de moyens d'engagements.

Le simulateur de Tir de Combat DX 175 apporte aux utilisateurs une **formation tactique indispensable**, les rendant capables d'appréhender les hauts niveaux de qualification pour les opérations de combat.

Le simulateur de Tir de Combat DX 175 est un système permettant l'entraînement tactique dans les conditions de combat réelles. Il permet de simuler toutes les formes de combat : sol-sol, sol-air, air-sol, air-air et permet une très grande variété de thèmes tactiques et de moyens d'engagements.

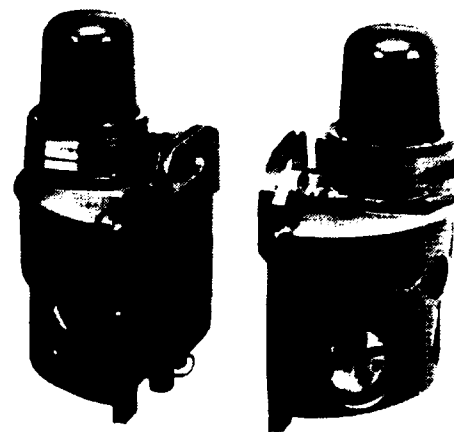
POLYVALENCY

The DX 175 Tactical Training Simulator is a system for evaluating the effectiveness of weapons fire during mock combats between land vehicles, tanks, armoured vehicles, etc., and for aircraft, helicopters and for infantry and artillery weapons, without exposing to any danger.

The simulator can be quickly installed in operational equipment without modifying their use or functions. It can simulate land vehicles, aircraft, helicopters, armoured vehicles and small calibre guns, tanks, armoured vehicles and rockets.

The DX 175 Tactical Training Simulator provides fighting units with **highly realistic battle training**, enabling them to test the operation of their weapons systems.

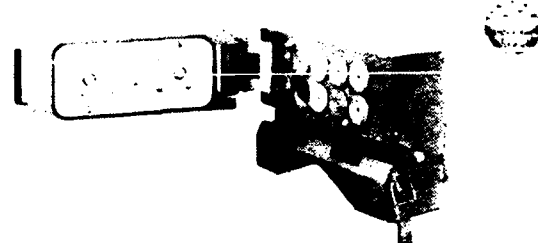
Le simulateur de Tir de Combat DX 175 est un système permettant l'entraînement tactique dans les conditions de combat réelles. Il permet de simuler toutes les formes de combat : sol-sol, sol-air, air-sol, air-air et permet une très grande variété de thèmes tactiques et de moyens d'engagements.



balise beacon

POLYVALENCY

The polyvalent nature of the DX.175 Simulator ensures considerable operational flexibility, a wide range of possible applications and easy logistic support.



UTILISATION

Le simulateur DX 175 peut assurer l'entraînement tactique à tous les niveaux : de l'unité de feu à la manœuvre interarmes.

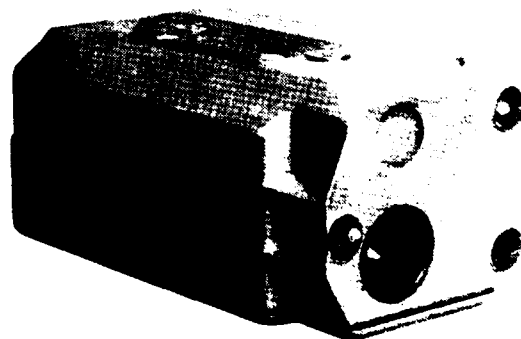
Il convient à toutes formes de combat : sol-sol, sol-air, air-sol, air-air et permet une très grande variété de thèmes tactiques et de moyens d'engagements.

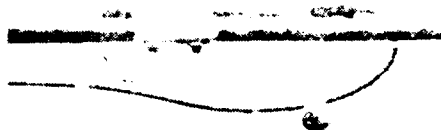
Tous les systèmes d'arme équipés en simulateur DX 175 sont compatibles - chaque véhicule / installateur de tir pouvant être indifféremment "chasseur" et "gibier".

COMPOSITION

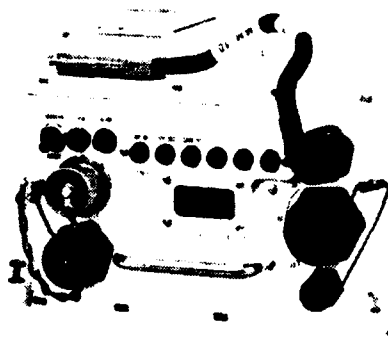
Le système complet DX 175 comporte des **ensembles principaux identiques** quels que soient le porteur (véhicule terrestre, poste de tir au sol, hélicoptère, etc...), et l'arme utilisée (canon, missile tactique, roquette).

Les caractéristiques spécifiques de l'arme simulée et le type de munition (projectiles balistiques, missiles guidés) sont introduits dans le simulateur à l'aide de cassettes enfichables.





Pyrotechnical generating devices-gunfire flash & direct hit



*boîtier électronique
processing unit*



UTILIZATION

The DX.175 Simulator allows tactical training at all levels, from an individual unit to interarm manoeuvres.

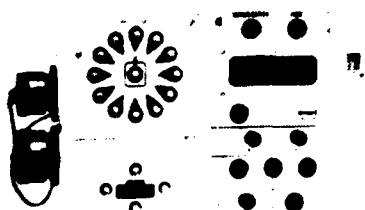
It is suitable for all forms of combat : ground-to-ground, ground-to-air, air-to-ground and air-to-air, allowing a wide range of tactical exercises and types of engagement.

All weapon systems fitted with the DX.175 Simulator are compatible, each opponent being either attacker or attacked.

COMPOSITION

The full DX.175 system comprises identical main assemblies, whatever the platform (land vehicle, infantry firing post, helicopter, etc...), and the weapon used (gun, tactical missile, rocket).

The characteristics specific to the simulated weapon and type of munition (ballistic projectiles, guided missiles) are fed into the Simulator by means of plug-in cassettes.



*boîtier de commande
control unit*

CARACTERISTIQUES TECHNIQUES

- Range : more than 4 000 m for all applications
- Types of munition which can be used against the same target : 7 different types of :
- guided missiles
- ballistic projectiles
- Accuracy
- ± 0.1 mrd (up to 10 mrd from the middle of the target)
- Environmental conditions
- Operating temperature range : -25°C to $+55^{\circ}\text{C}$
- Storage temperature range : -40°C to $+70^{\circ}\text{C}$
- Supply voltage : 20 to 30 V
- Laser energy density : $< 5 \times 10^{-7}$ J/cm²
(conforms to the formula of the norm ANSI Z 136-1-1976)

EQUIPEMENTS PERIPHERIQUES

FUSIL D'ARBITRE :

Un dispositif portable à la disposition de l'instructeur ou arbitre extérieur permet de :

- contrôler la réception des véhicules équipés
- activer et neutraliser les véhicules équipés

VALISE DE PROGRAMMATION :

Une valise facilement transportable permet de :
- lire les messages enregistrés sur cassettes
- reprogrammer si nécessaire les cassettes

SOUTIEN :

Un **autotest** intégré permet un contrôle interne du bon fonctionnement du Simulateur complet monté sur véhicule / poste de tir

Une **valise test** permet de localiser le sous-ensemble défectueux

TECHNICAL CHARACTERISTICS

- Range : more than 4 000 m for all applications
- Types of munition which can be used against the same target : 7 different types of :
- guided missiles
- ballistic projectiles
- Accuracy
- ± 0.1 mrd (up to 10 mrd from the middle of the target)
- Environmental conditions
- Operating temperature range : -25°C to $+55^{\circ}\text{C}$
- Storage temperature range : -40°C to $+70^{\circ}\text{C}$
- Supply voltage : 20 to 30 V
- Laser energy density : $< 5 \times 10^{-7}$ J/cm²
(Safety in accordance with ANSI Z 136-1-1976)

PERIPHERAL EQUIPMENT

CONTROL GUN :

A portable device used by the instructor or external umpire for :
- checking gun reception of equipped vehicles
- activating and neutralizing equipped vehicles

PROGRAMMING UNIT :

An easily transportable unit allows :
- reading of messages previously stored on cassettes
- cassette reprogramming if required

SUPPORT :

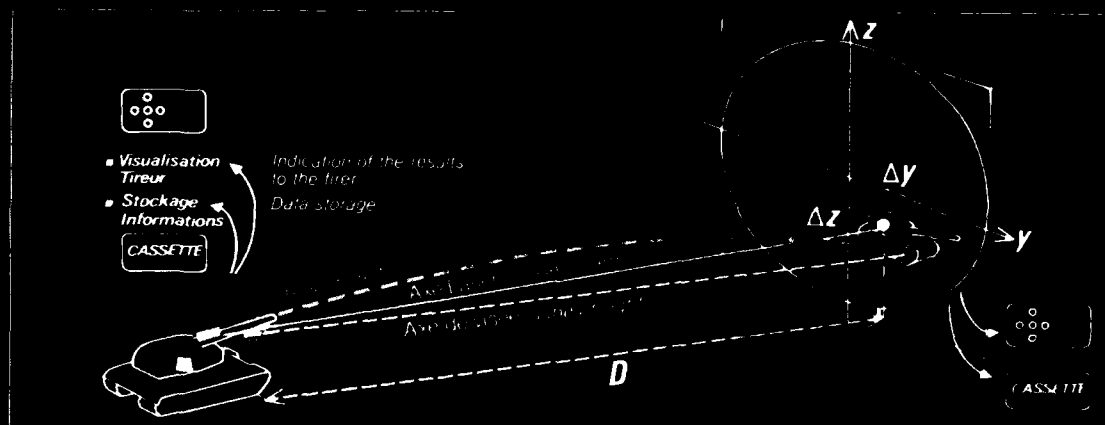
- A built-in **self test** for internal checking of the complete Simulator installed on a vehicle / firing post
- A **portable test set** for identifying a defective sub-assembly

FONCTIONNEMENT

Le tir simulé respecte fidèlement le déroulement de la séquence de tir propre au matériel opérationnel. L'équipage utilise les dispositifs de commande du système d'arme (lunette, système de pointage, mise de feu, etc.), et assure les mêmes manipulations et responsabilités que dans le tir réel.

OPERATION

Simulated firing faithfully follows the firing sequence of the operational equipment. The crew uses the weapon system controls (sight, aiming system, firing controls, etc.), performs the same actions and assumes the same responsibilities as in real weapon operation.



Fonctions réalisées

1. Acquisition de l'objectif par le tireur, pointage sur la cible et sélection du projectile.

2. TIR :

recherche de l'objectif et pointage automatique du faisceau laser sur la balise cible.

3. ÉCARTOMETRIE :

calcul du point de passage du projectile fictif dans le plan vertical de la cible.

4. TRANSMISSION DES INFORMATIONS :

- au "tireur" :
 - identité du tireur
 - type de munition tirée
 - point de passage du projectile
 - enregistrement sur cassette mémoire.
- au "cibleur" :
 - visualisation du résultat de tir
 - enregistrement sur cassette mémoire.

Functions performed

1. Acquisition of the target by the weapon operator, aiming at the target and selection of the projectile.

2. FIRING :

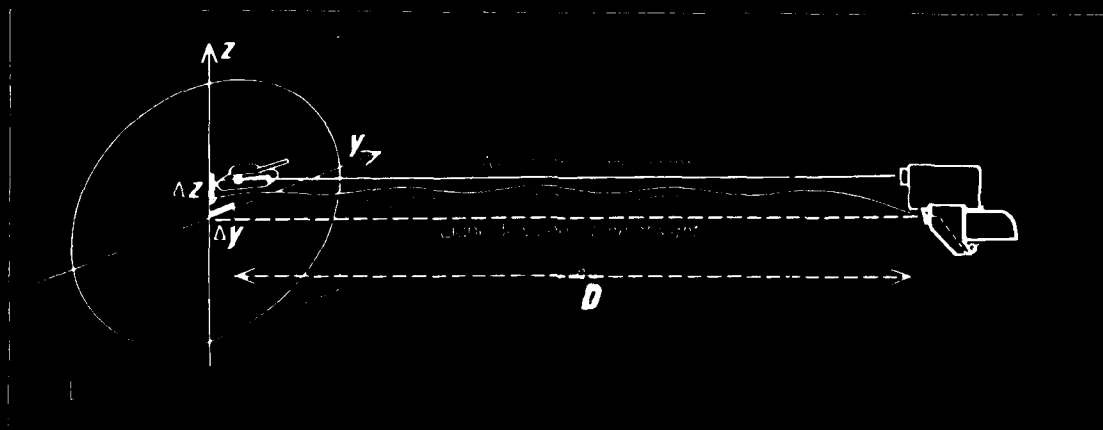
target search and tracking of the target beacon by the laser beam.

3. MISS DISTANCE :

calculation, in the vertical plane containing the target, of the projectile passing point coordinates.

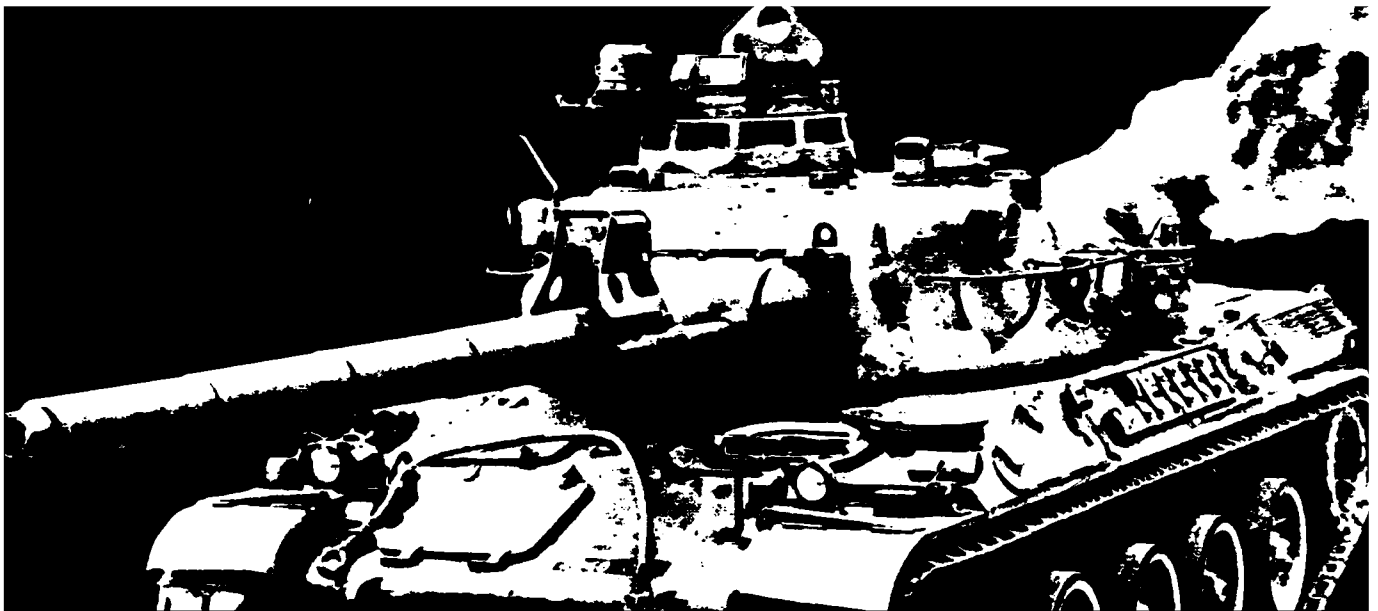
4. DATA TRANSMISSION :

- to the attacked party :
 - identity of the attacker
 - type of munition fired
 - projectile passing point coordinates
 - recording on a cassette.
- to the attacking party :
 - Indication of the fire result
 - recording on cassette.



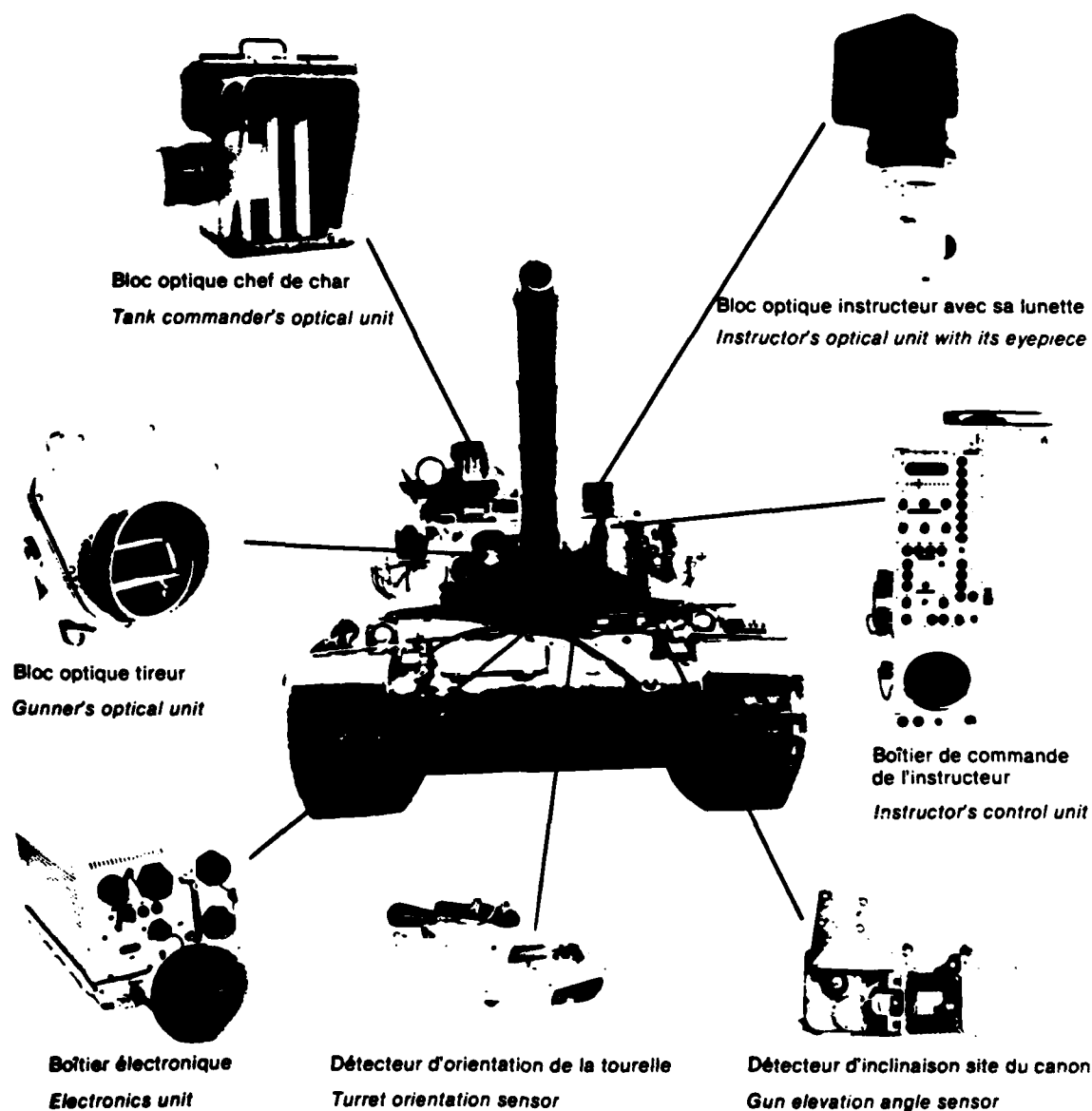
install (and remove). Installation can be done by unskilled personnel in less than 1 hour.

placed in the vehicle. A gunfire simulator for mounted in the vehicle.



GIRAVIONS DORAND industries

DX 150



Le simulateur DX 150 est un matériel d'instruction au tir au canon de 105, modèle F1 équipant les chars AMX 30, destiné à l'entraînement de leur équipage.

Installé à bord du char, il permet l'instruction sur le terrain dans les conditions réelles de combat en utilisant les commandes de tir opérationnelles.

The DX 150 Simulator is a gunnery trainer for the F1 105 mm gun on AMX 30 tanks, providing crew training.

Various versions of this simulator are also manufactured by GIRAVIONS DORAND Industries for other types of tank.

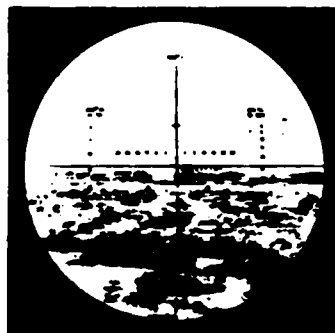
When installed in the tank, it provides field training under conditions closely resembling real combat, making use of the normal weapon system controls.

DX 150

ENTRAINEMENT AU TIR SUR CIBLES REELLES

Le simulateur DX 150 permet d'effectuer des TIRS FICTIFS sur des OBJECTIFS REELS, FIXES ou MOBILES.

La trajectoire du projectile est simulée par un spot lumineux (1), l'impact au sol par un éclat (2) suivi d'un effet de fumée (3), le coup au but par un éclat accentué suivi de l'effet de fumée.



GUNNERY TRAINING AGAINST REAL TARGETS

The DX 150 simulator allows the simulated engagement of FIXED or MOVING REAL TARGETS.

The trajectory of the projectile is simulated by a spot of light (1), impact with the ground by a flash (2), followed by the effect of smoke (3). A hit is represented by an accentuated flash, followed by the effect of smoke.



ENTRAINEMENT A LA VISEE SUR CIBLE FICTIVE

Le simulateur DX 150 permet également l'ENTRAINEMENT A LA VISEE.

Une cible lumineuse générée par le simulateur défile dans le champ optique du tireur, du chef de char et de l'instructeur.

Les écarts de visée sont mesurés et sanctionnés.

AIMING INSTRUCTION AGAINST A FICTIVE TARGET

The DX 150 system also provides INSTRUCTION in AIMING.

A luminous target generated by the simulator moves across the fields of view of the gunner, tank commander and instructor.

Aiming errors are measured and scored.

COMPOSITION DU SIMULATEUR DX 150

A l'extérieur du char :

- bloc optique tireur
- bloc optique chef de char
- bloc optique instructeur avec sa lunette
- détecteur d'inclinaison site du canon

A l'intérieur du char :

- boîtier de commande de l'instructeur
- boîtier électronique
- détecteur d'orientation de la tourelle.

COMPOSITION OF THE DX 150 SIMULATOR

Outside of tank :

- gunner's optical unit
- tank commander's optical unit
- instructor's optical unit with its eyepiece
- gun elevation angle sensor.

Inside the tank :

- instructor's control unit
- electronics unit
- turret orientation sensor.

CARACTERISTIQUES

- munitions simulées : OE et OCC
- distance : 500 à 4000 m
- Nombre de cibles réelles : 10 fixes et 1 mobile
- inclinaison du canon : + 20° à - 9°
- inclinaison des tourillons : + 20°
- rotation de la tourelle : 360°
- température de fonctionnement : - 25° à + 55°C
- température de stockage : - 40° à + 70°C
- alimentation : 27 V CC, 6A
- boîtier électronique à base de microprocesseurs permettant une mémorisation :
 - des caractéristiques du terrain
 - des caractéristiques des 10 cibles fixes et de la cible mobile
 - des données balistiques du projectile
 - des données aérologiques
- maintenance assurée par une Valise test déterminant le sous-ensemble défectueux.

CHARACTERISTICS

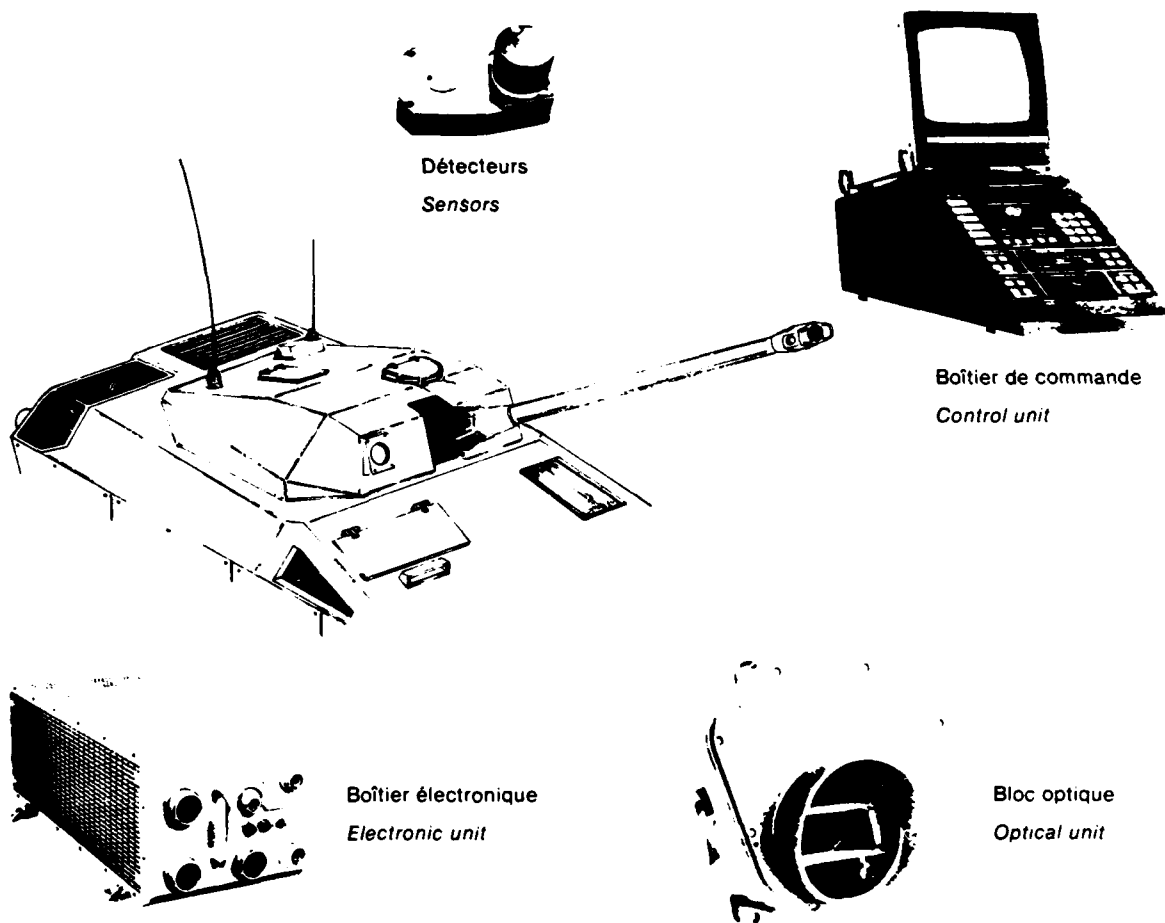
- ammunition simulated : HE and AP
- range : 500 to 4000 m
- number of real targets : 10 fixed and 1 moving
- gun elevation range : - 9° to + 20°
- trunnion tilt : ± 20°
- turret rotation : 360°
- operating temperature range : - 25°C to + 55°C
- stockage temperature range : - 40°C to + 70°C
- power supply : + 27 V DC, 6A
- microprocessor-based electronics for storing
 - terrain characteristics
 - characteristics of the 10 fixed targets and of the moving target
 - ballistic data of the projectile
 - meteorological data
- identification of defective subassemblies by a maintenance Test Set.

GIRAVIONS DORAND industries

DX 156

SIMULATEUR POUR L'INSTRUCTION AU TIR DIRECT SOUS TOURELLE

TURRET FIRING TRAINING SIMULATOR



Le simulateur DX 156 est destiné à l'instruction des tireurs de chars et véhicules blindés équipés d'une tourelle-canon.

Installé à bord du véhicule, le simulateur DX 156 permet l'instruction sur le terrain, dans des conditions réelles d'utilisation de l'arme et ne nécessite ni terrains d'exercices spéciaux, ni cibles coopératives.

Le même simulateur, associé à une tourelle réelle ou simplifiée, peut être utilisé en salle pour l'instruction préliminaire.

The DX 156 Simulator is intended to train the gunners of tanks and armoured vehicles equipped with a gun turret.

Installed on the vehicle, the DX 156 simulator enables field training, in real weapon operating conditions and requires no special firing ranges nor cooperative targets.

Associated with a real, or simplified, turret, the same simulator may be used indoors, for preliminary training purposes.

Saab BT 41

The most realistic and versatile simulator system
for tank crew training.



Realistic tank crew training. A difficult task.

Armoured combat combines mobility with the skillful use of gunnery and terrain. Correct behaviour in the terrain is of utmost importance. Proficiency in gunnery is equally important. It does not matter how well you maneuver in the terrain if you can not stop the aggressor.

To obtain the skill needed to hit an evasive, fast moving tank requires precision training. However, effective training is difficult to accomplish.

Today, live ammunition or special training ammunition is used in basic gunnery training. Large scale live ammunition gunnery training does unfortunately present great problems.

The economic impact is the same all over the world. The cost of ammunition is increasing, and at the same time, defence budgets are being cut.

Training areas for live firing are diminishing. There are only limited areas in the world where vast land is available for realistic training with real ammunition, and this land is far away from the home base. In most countries, the land available as training ranges is shrinking due to need of the land for other purposes. Nevertheless, the firing range of modern, fast ammunition and the mobility of modern tanks require larger areas for training.

SAFETY

Safety precautions, especially for modern ammunition, have become more and more pronounced. For instance, it is almost impossible to

arrange firing on-the-move against suddenly appearing targets, for safety reasons.

In fact safety problems govern the degree of realism that can be obtained during live-fire gunnery training. Firing, generally, is at fixed targets, and the gunners quickly learn the position and range of the targets. They learn to shoot well, in a pure training situation. For training against moving targets, rail track targets are normally used. The gunners quickly learn where to expect a target to appear and also the correct sighting, for the range and speed of the targets.

PROFICIENCY

The demands put on the tank crew during a fast moving, dynamic combat are very great.

The safety requirements, the organization problems and the cost of live or training ammunition, are factors which contribute to decreased training effectiveness simply because today the gunner can not fire enough practice rounds at realistically appearing and moving targets to develop maximum skill. Safety requirements restrict the effective training of tank crews in utilizing maneuvers and terrain.

SIMULATED FIRING, A SOLUTION

Use of laser based simulation is a powerful solution to many of the training problems. With simulated firing, the gunner can fire thousands of "rounds" with no restrictions due to cost of ammunition or gun-tube wear. The training is not confined to firing ranges only, it can take place at any suitable site. The safety problems are nil, and training realism can be increased as a bonus. Altogether, this can result in greater training effectiveness, i.e. lower costs and top notch tank crew proficiency.

BEWARE OF NEGATIVE TRAINING

Poor fidelity in the simulation will, however, ruin a good idea. If simulation is to be used to train gunnery, the simulator must take into account all relevant characteristics.

Oversimplified simulation results in lack of realism which gives negative training – i.e. the soldier is trained to behave in a way which is not relevant to real combat situations or to the firing of live ammunition.

The laser gun, in its simplest form, can be compared to a flash-light. Due to the light-beam dispersion, it is as easy to hit a target at 3,000 m as at 300 m with this type of gun. Also, the beam is straight and travels at the speed of light.



When firing at fixed targets, gunners learn to shoot well in a pure training situation.



Firing on the move – almost impossible to train realistically without a simulator.

Obviously, this type of "gun" can not be used for basic gunnery training as it does not simulate the curved trajectory etc.

In addition when used for tactical training, this type of simulation will have serious negative training effects.

E.g. the soldiers will, in the environment with high resemblance to the real combat situation, be trained to neglect super-elevation and lead-angle corrections.

When the soldier comes into real combat, he will most likely use the gunnery procedures trained in similar situations and not the procedures trained on the firing range. Simple "laser guns" may thus be deadly for the trainee and must only be used with serious considerations.

The only safe simulator is the one which takes all relevant characteristics into account. The Saab BT 41 is such a safe simulator.



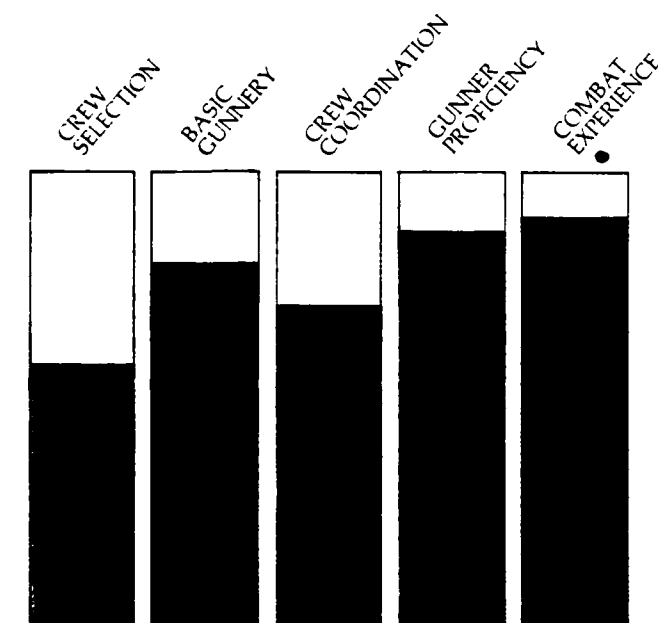
Give your tank crew real experience today – or someone else might tomorrow.

The Saab BT 41 concept. Realism and versatility.

The education of a tank crew is a process with different training phases where the crew is gradually trained to perform a task.

Today, a number of training aids are used – a new one for each training phase. Such “part task” trainers represents large investments that can only be used during a short period of each educational sequence.

The effectiveness of training equipment can be measured by the total number of needs it will fill during the training period. It is, however, important to see that the equipment makes a high fidelity simulation like the BT 41, otherwise it will induce negative training, especially in the later training phases.



The versatility and the realism of the BT 41 meets most of the demands an instructor may have during the different training phases. The flexibility and programming capability of the system make it suitable for all phases – from crew selection to experiential training.

REQUIREMENTS IN TRAINING

The instructors must meet the requirements of training the crew to a specified proficiency. For this, different methods and aids will be used during the various phases of education.

CREW SELECTION

Some people are by nature good gunners, others will require an unrealistically large amount of training to make a good showing. The selection of good gunners is important since it has a great effect on the initial training results. Using a simulator which can give relevant result print-out makes it easy to undertake this selection.

BASIC GUNNERY

Once selected, the gunner must learn basic gunnery procedures. This involves training the skill of aiming at stationary and moving targets. When using a sighting system (primary or secondary) without ballistic or lead-angle computer, it also involves the training of correct aiming by using the reticle scales in the sight.

This initial training can be performed against simulated targets, e.g. light-spots reflected into the gunners sight. With print-out of aiming motions, time for aiming and final aiming error, the instructor can assess the trainees performance and learning and give corrective information.

CREW COORDINATION

The tank is a weapon which requires coordination between its crew members to perform well. Each member has a specific task, and when the basics of those tasks have been learned, the coordination training starts. Preferably, this training can be performed in the field with pop-up targets and/or other simulated targets, both stationary and moving.

GUNNER PROFICIENCY

The gunner's proficiency in precision gunnery is one of the most important factors in a battle. To reach the skill needed to hit an evasive, fast moving tank requires good training. This includes firing a vast number of rounds under realistic conditions. With simulated firing, realistically moving targets can be used but the simulation must have high realism like the BT 41, or the result will be negative learning. One of the most important training phases thus also puts the greatest demands on the methods and aids used.

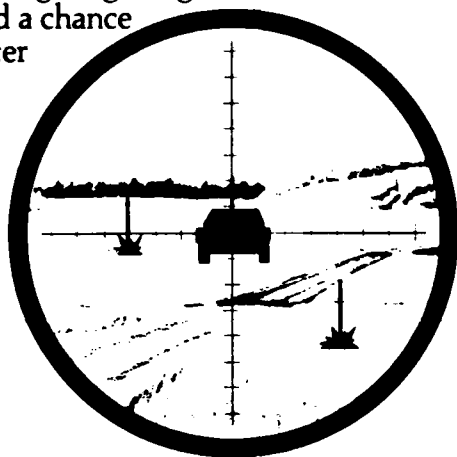
COMBAT EXPERIENCE

Real combat training is invaluable. The instructors must, however, give the trainees good “combat” experience, experiential training before the outbreak of hostilities. To do this, the training environment must duplicate actual battlefield conditions. Force-on-force training using simulated firing and effect assessment is a common way to obtain experience.

With simulators less qualified than the BT 41, the methods and aids used to assess the simulated battle might affect the result and, at worst, result in negative training. Obviously; less-than-perfect simulation of the firing and hit-effect assessment not only reduces the validity of results but also weakens the trainee's motivation and gives negative training effects.

REALISM AND VERSATILITY

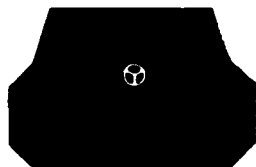
Precision simulation with BT 41 is the answer to many training problems. BT 41 can simulate exactly the trajectory of a projectile in real time. The requirement for a hit is that the projectile and the target reach the same position at the same moment. The BT 41 can also simulate a tracer burn and a projectile burst into the gunner's sight, giving the gunner an immediate feedback and a chance to a better second round.



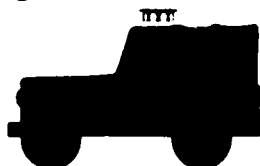
The gunner can, from this information, immediately analyse how and why he missed the target. He may have misjudged the range and used the wrong elevation, or he may have misjudged the speed of the target and used wrong lead-angle. By using BT 41, every gunner has the opportunity to fire thousands of rounds at targets suddenly appearing in the training area.

Furthermore, every tank crew can be given appropriate training so that the sequence of target identification, sighting and firing becomes automatic and reflexive.

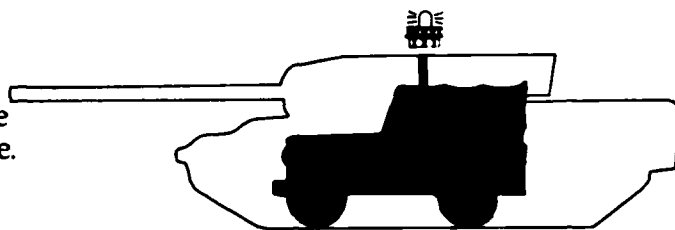
The driver and tank commander learn to use the terrain to avoid being hit by others. This type of training is effective because it is related to performance and realistic, giving the stress and dramatics very close to an actual combat.



For basic training, the target in its simplest form can be a remote controlled pop-up tank silhouette target fitted with a reflector prism.



A moving target can be provided by fitting a jeep with a number of reflectors to cover 360°.



A more advanced target is obtained by fitting the same jeep with the target simulation assembly of BT 41, to get an evaluation of the effect of each hit.



A variety of hit indicators can be connected to the BT 41 target simulator – for example, flash discharge lamps, pyrotechnic markers or smoke devices. The total simulation is represented by a tank equipped with the complete BT 41 system.



How the system works.

The BT 41 can operate in many different modes controlled by software. A standard mode will have the following simulation sequence:

STABILIZED TRAJECTORY SIMULATION

At the moment of triggering the gun, a direction equal to the gun barrel direction is defined by starting computation of the signals from gyros in the laser unit. Therefore, change of gun barrel direction after moment of triggering does not influence the hit result. (Fig 1.)

The computer starts calculating the position of the simulated projectile relative to the inertial stable direction isolated by the gyros.

The laser-beam searches for retroreflectors around the projectile. (Fig 2.)

TRACER SIMULATION

A tracer simulation can be introduced into the gunners sight by a light-spot displaying the momentary position of the projectile during the time of flight. (The tracer size decreases to simulate increasing range.) (Fig. 3.)

FALL-OF-SHOT MEASUREMENT

The procedure above continues until a reflector is found. When this occurs, laserbeam reflections are used to determine angular position of the reflector relative to the calculated projectile position and range. Upon reaching the target, the tracer brightness is first increased momentarily, simulating a burst, and then disappears. (Fig. 4.)

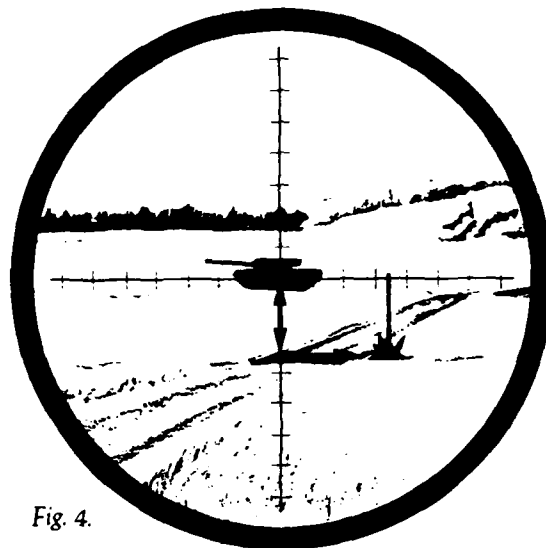


Fig. 4.

CODED LASER BEAM

When reflections are obtained from the reflector on the target a computation is made to calculate the deviation distance between the reflector and the projectile position at the reflector's range. This information is then transmitted via the laser beam. Information giving projectile type and identity of the attacking unit is also transmitted. (Fig. 5.)

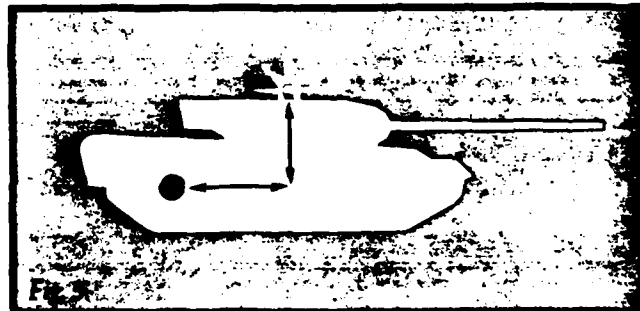


Fig. 1.



Fig. 2.



Fig. 3.

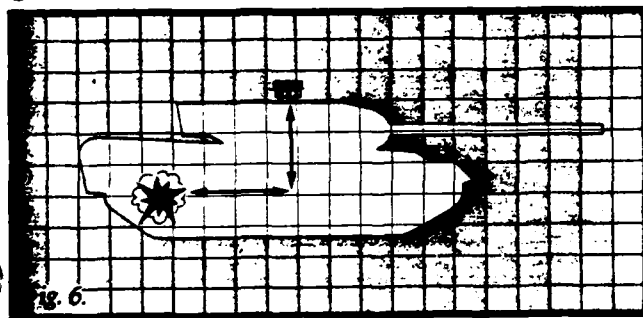
TARGET SIMULATION

Radiated laser pulses containing information are picked up by detectors at the target. These detectors are mounted with the retroreflectors in the reference unit.

Thus, the target receives information on the coordinates of a passing projectile with the reference unit position on the target as origin. The target is also informed of the identity of the attacking unit, and type of projectile used.

The reference unit has 12 detectors with overlapping fields of view covering 360° in azimuth and $\pm 20^\circ$ in elevation. One or two of these detectors will be hit by the laser pulses which give the direction to the attacking unit.

The target has tables over vulnerabilities in a grid net stored in its electronic memory. (Fig. 6.)



One such net is given for each of 12 different attacking directions.

From the coordinates of the hit, or passing position of the projectile, the BT 41 target computer first makes a hit/miss decision (inside or outside the target contour). If there is a hit, the effect of the hit is evaluated. (Fig. 7.)

Each one of the defined kill probabilities, e.g. fire-power kill, mobility kill etc, is then evaluated

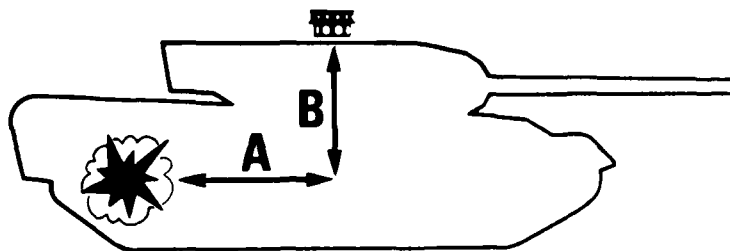
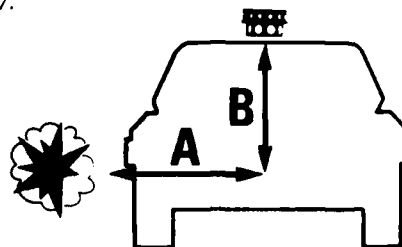


Fig. 7.



using a random number generator giving a kill/no kill decision.

DEFILADE SIMULATION

The target can also be equipped with hull detectors. These are positioned on the lower part of the target and are usually split into 4 parts, each including 3 detectors covering 90° in azimuth.

When these detectors are hit by laser pulses, they sense the direction to the attacking unit (relative to the lower part of the target) and thus determine the proper probability grid net for this part. If, the defilade detectors are not hit, this will be taken as an indication of a target partially in defilade and the lower part of the target will be assumed not to be hit sensitive.

The Saab BT 41 system configuration.

Functionally the BT 41 consists of 2 sub-systems; one for firing and one for hit recording. The firing is done by laser pulses emitted by a laser-unit mounted in the gun of the tank. Hits are recorded by detector modules on the target tank and all essential information, i.e. type of ammunition used, range to target and hit position, as well as misses, are monitored by a display and printer placed in the tower. Hits can be indicated either by sound, smoke or flashing light.

The BT 41 system is very versatile and can also be used in conjunction with conventional, stationary targets or any type of vehicle for

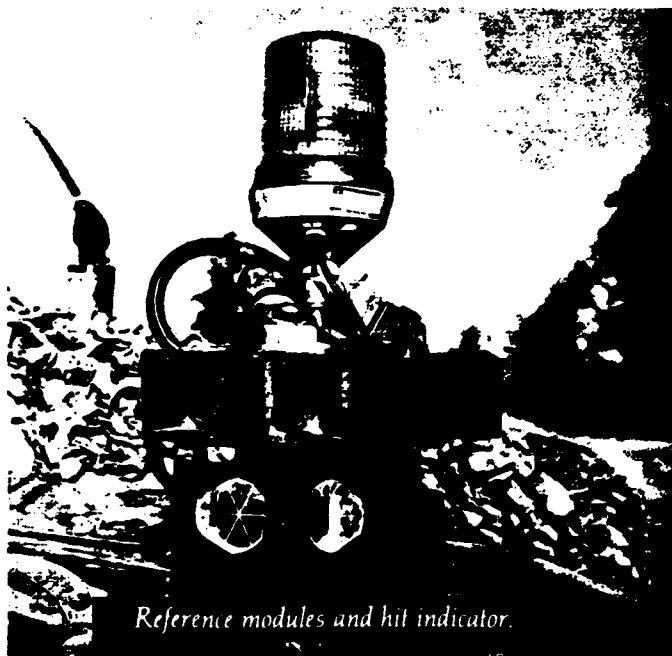
basic fire training purposes. For this, only the fire simulator set is needed on the firing tank and only a simple reflector is required on the target.

EASY TO INSTALL AND MAINTAIN

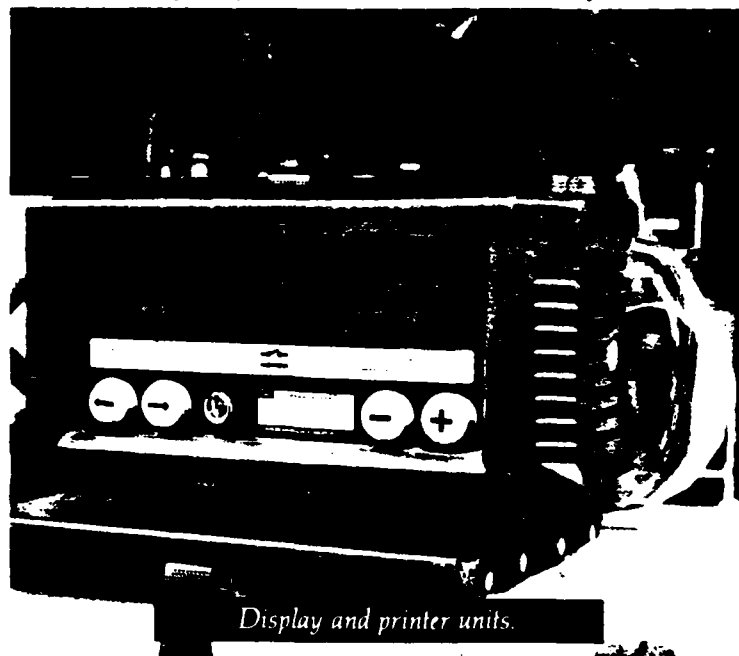
The modular, heavy-duty design of the Saab BT 41 system enables it to withstand the rough environmental conditions encountered in tanks.

Easily accessible sub-modules and the built-in self-test system facilitate maintenance and trouble-shooting.

The design lay-out makes the BT 41 easy to



Reference modules and hit indicator.



Display and printer units.



Laser unit.

install (and remove). Installation can be done by non-skilled personnel in less than 1 hour.

The complete BT 41 system consists of the units pictured below. Power is supplied by the vehicle's standard 24 VDC supply.

In the firing only simulator set there is a calculator unit which can be placed anywhere on the vehicle, one or more tracer units which are installed over existing gunner and/or commander's optics, a laser unit which is placed either in or on the gun barrel, a display unit which is placed in the vehicle close to the loader or the commander, and a printer unit which is also

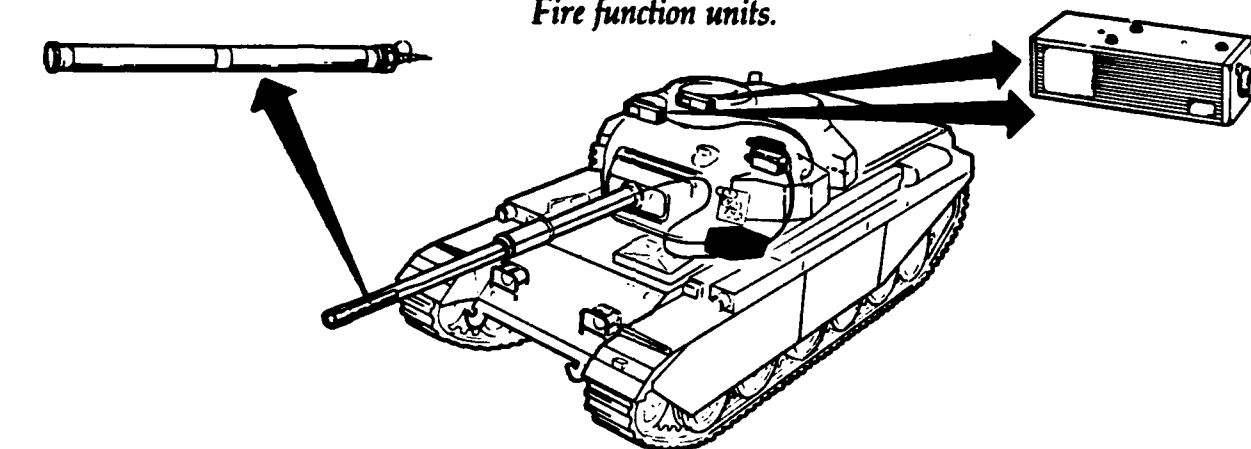
placed in the vehicle. A gunfire simulator for pyrotechnics may also be added.

For combat simulation, a reference unit which can be divided into four quadrants (to facilitate mounting on the vehicle) is added.

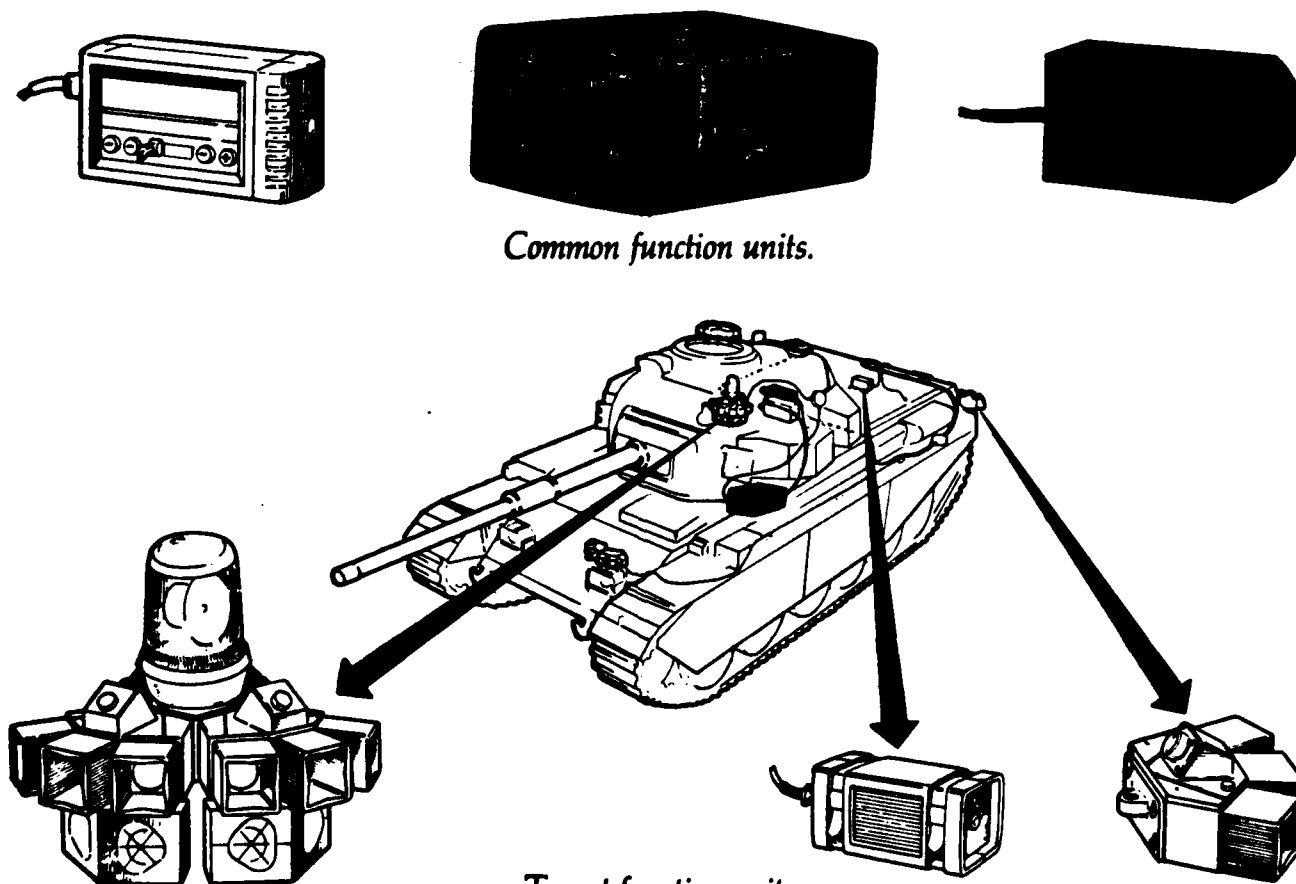
For target simulation only, the reference unit, calculator and display unit are needed. Printer and hit indicator may be added.

A hull detector set can also be added to the target simulator. This consists of four detector quadrants and a communication unit.

Fire function units.



Common function units.



Target function units.



Saab BT 41 stimulates and motivates tank crew resulting in increased proficiency.

Saab BT41 in action.

The Saab BT 41 may be described as a "transparent" system, i.e. the procedures used with the simulator system are identical to those applied during firing with real ammunition.

A simulator must not affect either the loading or firing procedures or the operation of the tank, as this would introduce the risk of "negative learning".

Assuming that a BT 41 is fitted to a tank, the following procedures and event sequence would be typical: before moving out to combat, the BT 41 is assigned with the type and amount of ammunition assumed to be available in the tank. This is done via the display unit by the commander or an umpire. This unit can be locked to prevent the crew assigning more ammunition during the exercise.

When the commander spots a target he gives direction information to the gunner, who brings the gun to bearing. Depending on the commander's order, the driver stops the tank or continues driving for fire on the move. The commander decides what type of ammunition he wants to be fired and gives the loading order.



The loader selects the ammunition by pushing the proper button on the display unit. If the tank has an automatic loading system the BT



41 can be interfaced with the regular loading controls. A time delay simulates the time it would take to load and the display unit shows when the selected ammunition is loaded. The loader informs the gunner and the commander when ammunition is loaded.

If a ballistic computer is used in the tank, the gunner sets the ammunition selector to the correct position. The BT 41 is independent of this information. The commander, or the gunner, estimates or measures the range to the target and target cross-speed, using the normal equipment. The BT 41 is also independent of this information and does not require input of range or cross-speed.



THEN THE GUNNER PULLS THE TRIGGER...

The gunner aims at the target. If no ballistic and/or lead-angle computer is used he must manually apply appropriate super-elevation and lead-angle for the given range and cross-speed for the loaded type of ammunition. The gunner pulls the trigger. If connected to the BT 41, a pyrotechnical BT 19A gunfire simulator fires. The BT 41 starts the real time projectile trajectory simulation at the moment of triggering. A tracer light spot is simulated into the gunner's and commander's sight to simulate a tracer projectile.

The BT 41 measures the fall of shot at the moment when the simulated projectile passes the range sphere through the target. The tracer light stops and the luminance is momentarily increased to simulate a burst. The gunner and the commander evaluate the fall of shot as simulated by the burst.

The fall of shot, type of ammunition fired and the identity of the firing unit are transmitted via the laser beam to the target. The fall of shot is displayed and printed out in the firing tank. The point of impact and the hit-effect are displayed and printed out in the target. If a hit is determined, the target's hit indicator flashes to show the effect to the firing tank. Pyrotechnical devices may also be utilized to show the hit-effect.

FEEDBACK

Effective gunnery training also presupposes corrective information, i.e. results feed-back and continuous assessment of the gunner's performance. The more real the feed-back, the more effective the training.

The feed-back system must offer both short-term and long-term facilities. Short-term feed-back is essential to give the trainee an instant indication of results at the moment when all his senses are occupied with the particular conditions for each shot.

To obtain this, the position of both hits and misses (including wide misses) must be presented. The best learning reinforcement is obtained with a realistic realtime feed-back such as a tracer burn and projectile burst simulation into the gunner's sight.

Long-term feed-back is needed for post-exercise analysis and critique. A print-out of shot results is essential to give the instructor objective data for results analysis, so that he can make a correct critique of the crew's performance after an exercise. This results print-out is also the instructor's data for continuous assessment of gunners' performance and progress.

AMMO: APDS	REM: 32	Type of ammunition fired.
RANGE: 2186 m		Remaining number of rounds.
ELEV: + 1.5 m		Range to target.
AZIM: + 3.6 m		Fall of shot.
1981 10 11 10 16 56		Identity of attacking tank.
HIT: 10:08 AM 15		Lethality code of fired ammunition.
TURRET: 15°		Direction of fire relative to turret.
ELEV: + 1.5 m		Point of impact.
AZIM: + 3.2 m		Probability of kill.
KILL PROB: 45 %		
1981 10 11 10 17 08		
AMMO: HEAT	REM: 8	
RANGE: 892 m		
ELEV: + 2.2 m		
AZIM: + 1.7 m		
1981 10 11 10 17 14		Year, Month, Day, Hour, Minute, Second.
HIT: 10:08 AM 15		
TURRET: 15°		
ELEV: + 1.1 m		
AZIM: + 1.2 m		
*** DESTRUCTION		
1981 10 11 10 17 19		

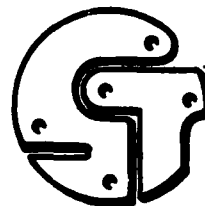
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The Saab BI 41 is protected by patents in major countries of the world

Honeywell

SONDERTECHNIK



ON – BOARD – GUNNERY SIMULATOR

mk20

WITH
HONEYWELL

VISUAL SIMULATION SYSTEM

CSI

(COMPUTER SYNTHESIZED IMAGERY)

APRIL 1983

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MX20



COMPUTER CONTROLLED TRAINING SYSTEM

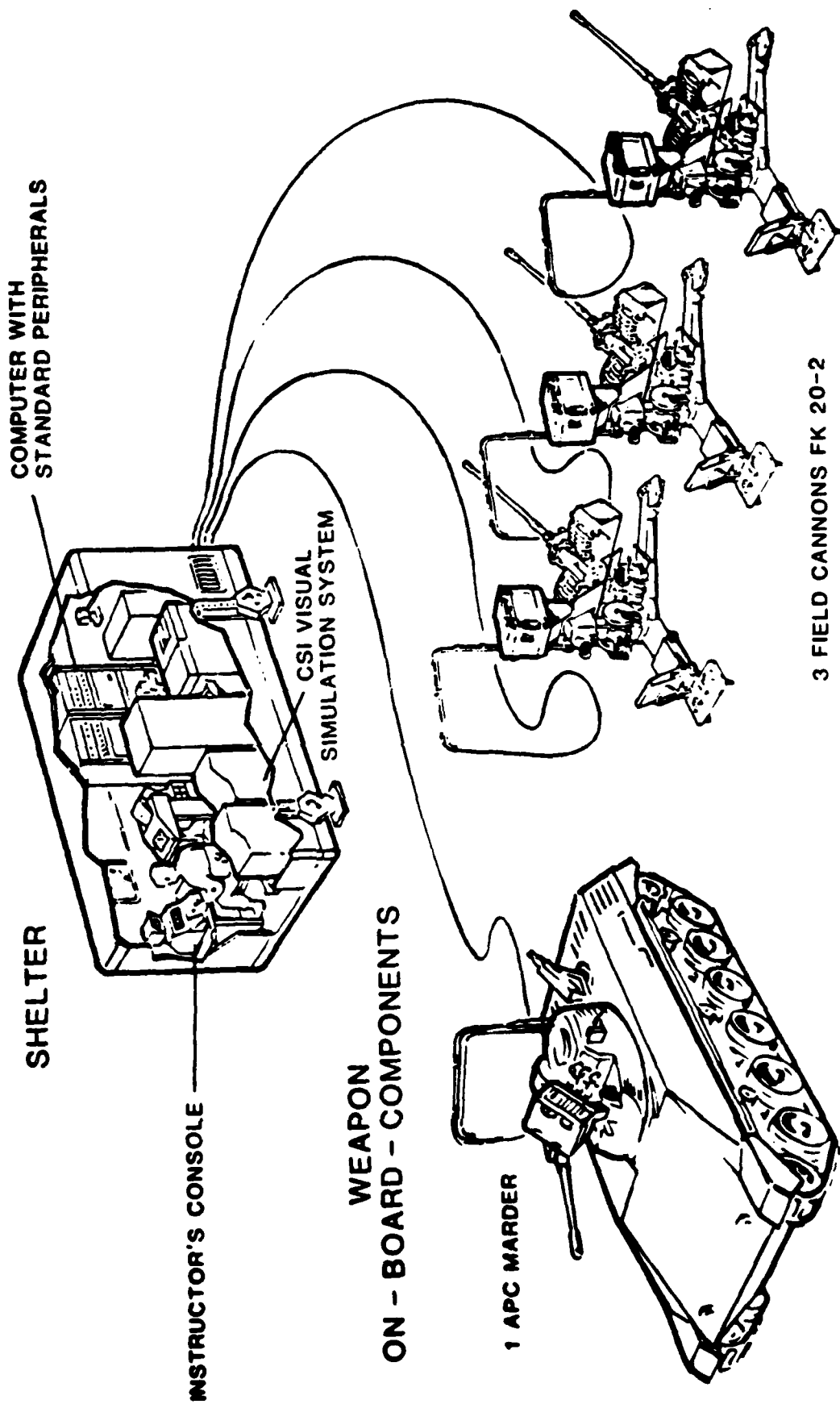
- FOR THE SIMULTANEOUS TRAINING OF UP TO 20 GUNNERS
- ADAPTABLE TO 20mm CALIBER MACHINE CANNONS
MOUNTED ON
 - FIELD CANNON - **FK 20-2**
 - ARMORED PERSONNEL CARRIER - **MARDER**
 - ARMORED RECONNAISSANCE CARRIER - **LUCHS**
- FOR INDIVIDUAL TRAINING
- FOR PLATOON TRAINING



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SIMULATOR OVERVIEW

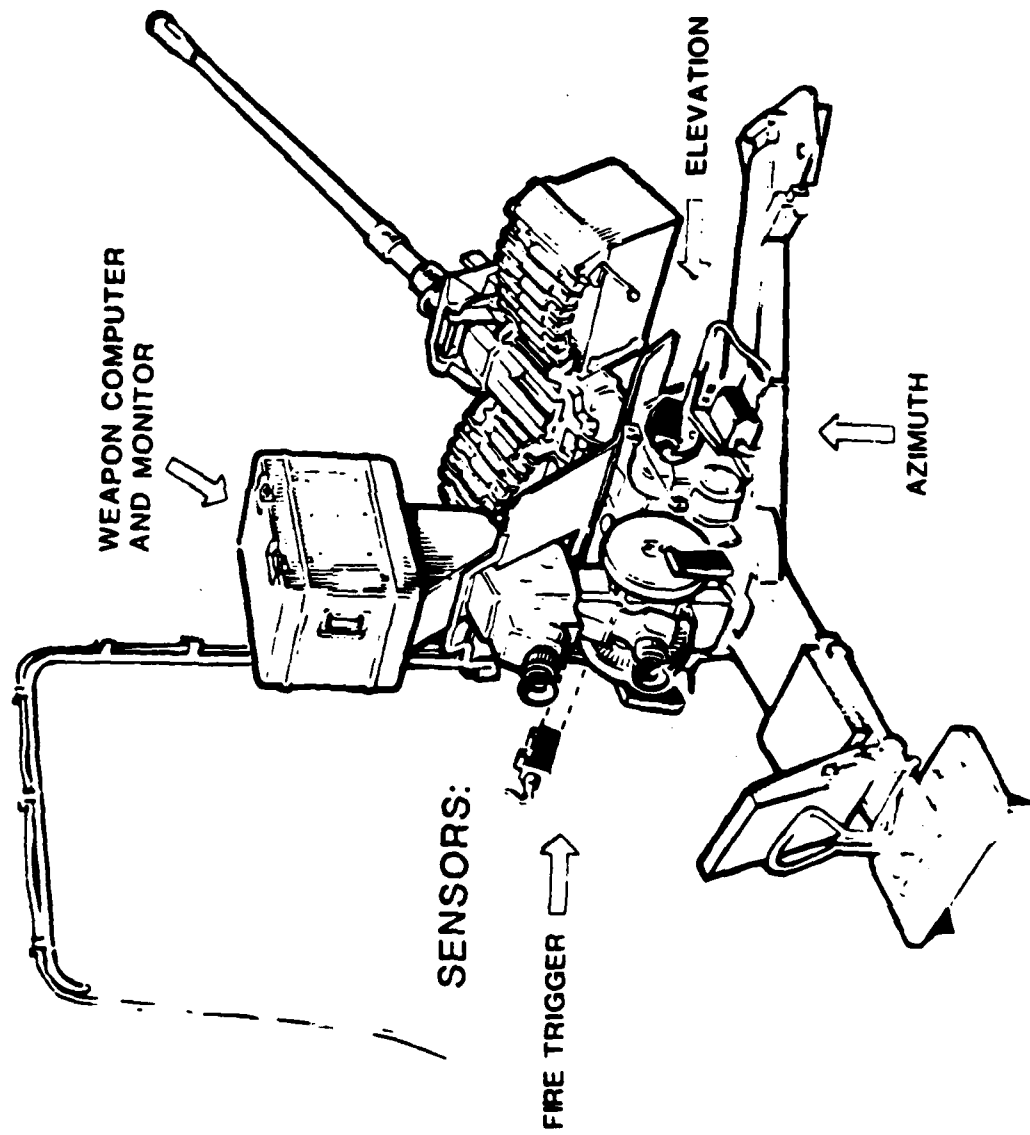


MH20

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WEAPON ON-BOARD-COMPONENTS, FIELD CANNON

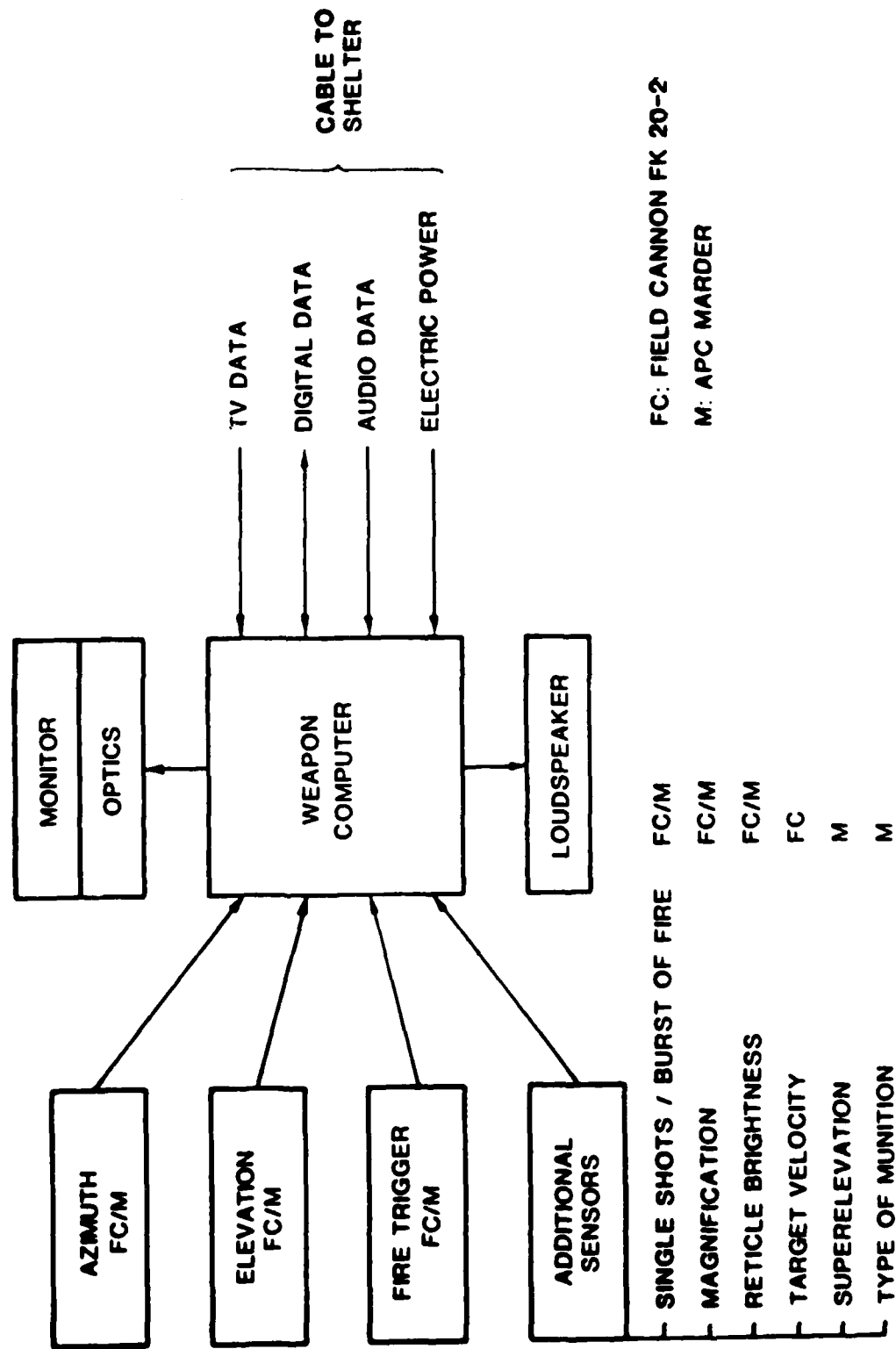


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WEAPON ON-BOARD-COMPONENTS



AD-A138 424

LIGHT ARMORED VEHICLE (LAV) TRAINING EQUIPMENT SURVEY
FOR THE US MARINE CORPS (U) EAGLE TECHNOLOGY INC ORLANDO
FL C FAGAN ET AL. 15 DEC 83 C731.08

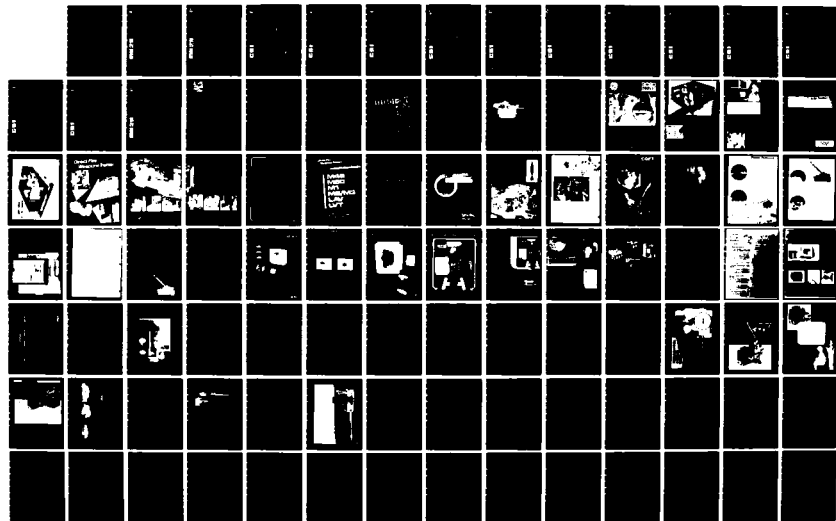
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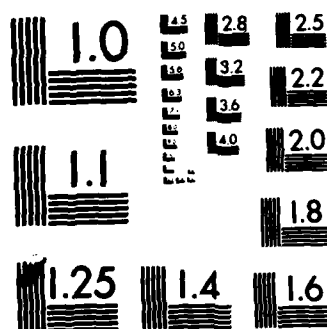
UNCLASSIFIED

NAVTRAEQUIPC-N-25-84-13 N61339-82-D-0004

F/G 5/9

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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TRAINING FEATURES

- TARGET ACQUISITION
- GUN LAYING
- TARGET AIMING
- TARGET ENGAGEMENT
 - FIRING
 - SHOT SENSING
 - SHOT CORRECTION



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SIMULATOR FEATURES

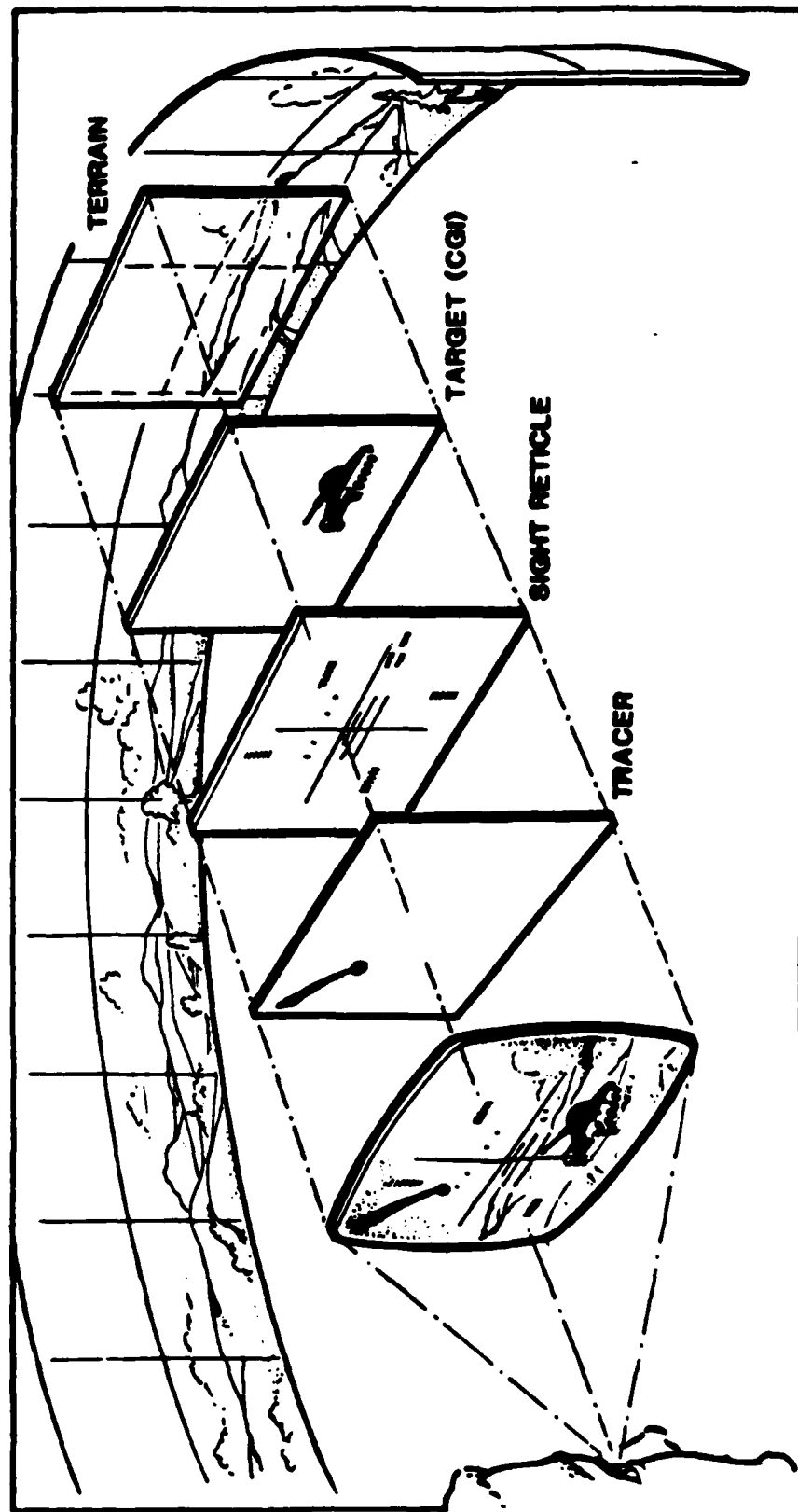
- **GUNNERY SIMULATION**
- **INDIVIDUAL / PLATOON FIRING**
- **BATTLEFIELD SIMULATION**
 - REALISTIC PRESENTATION OF
PANORAMA 360°x 90°
STATIONARY OR MOVING TARGETS AIRBORNE
OR GROUND TARGETS
 - VISIBILITY OBSCURATION EFFECTS
 - RETICLE PATTERN
 - TRACER TRAJECTORY
 - IMPACT FLASH (HIT)
- **FIRING RESULTS DISPLAY**
- **INTERCOM INSTRUCTOR / STUDENT(S)**
- **INDIVIDUALLY MONITORING OF
SELECTED GUNNERS**



CSI

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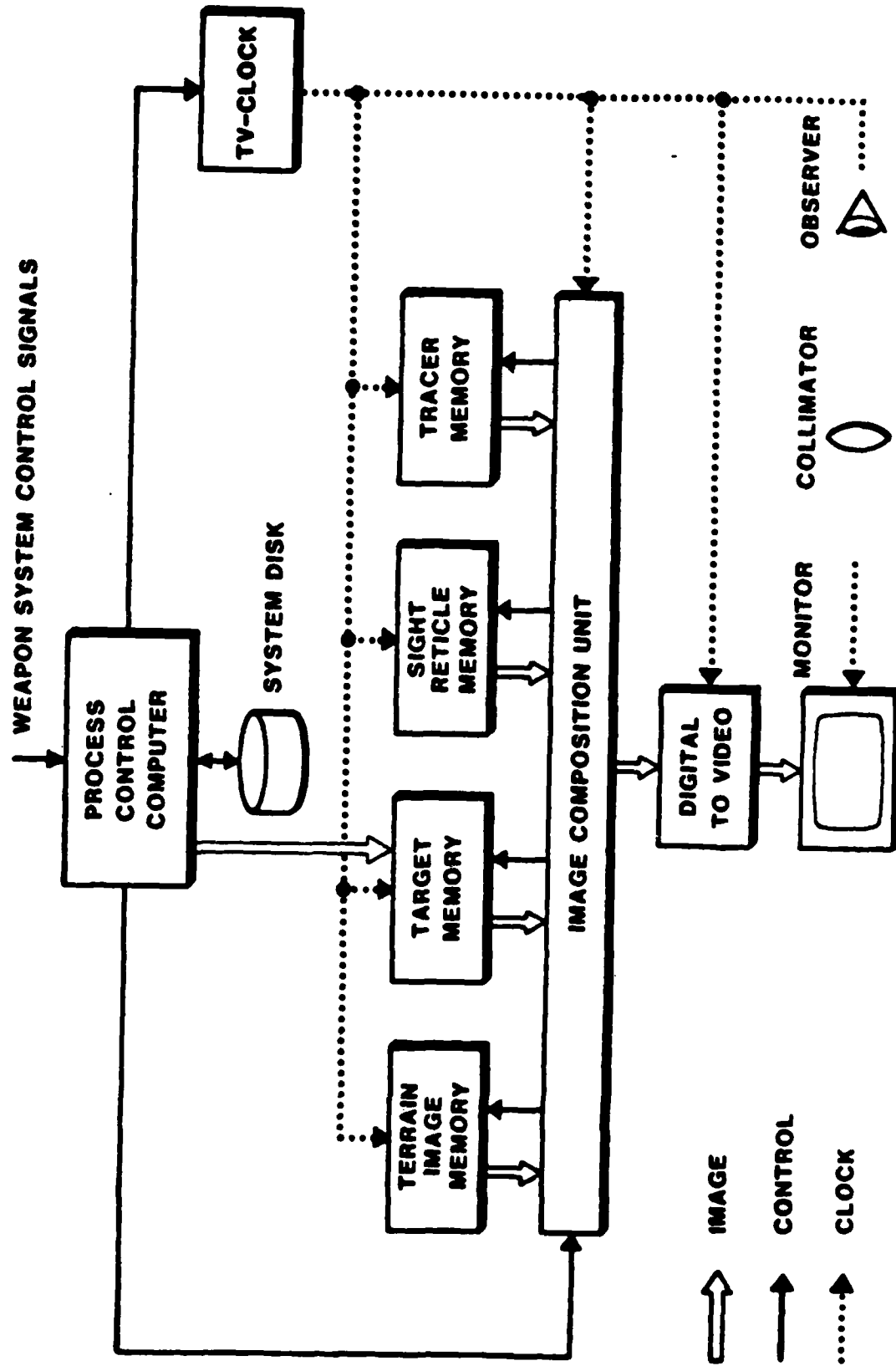
BASIC PRINCIPLE



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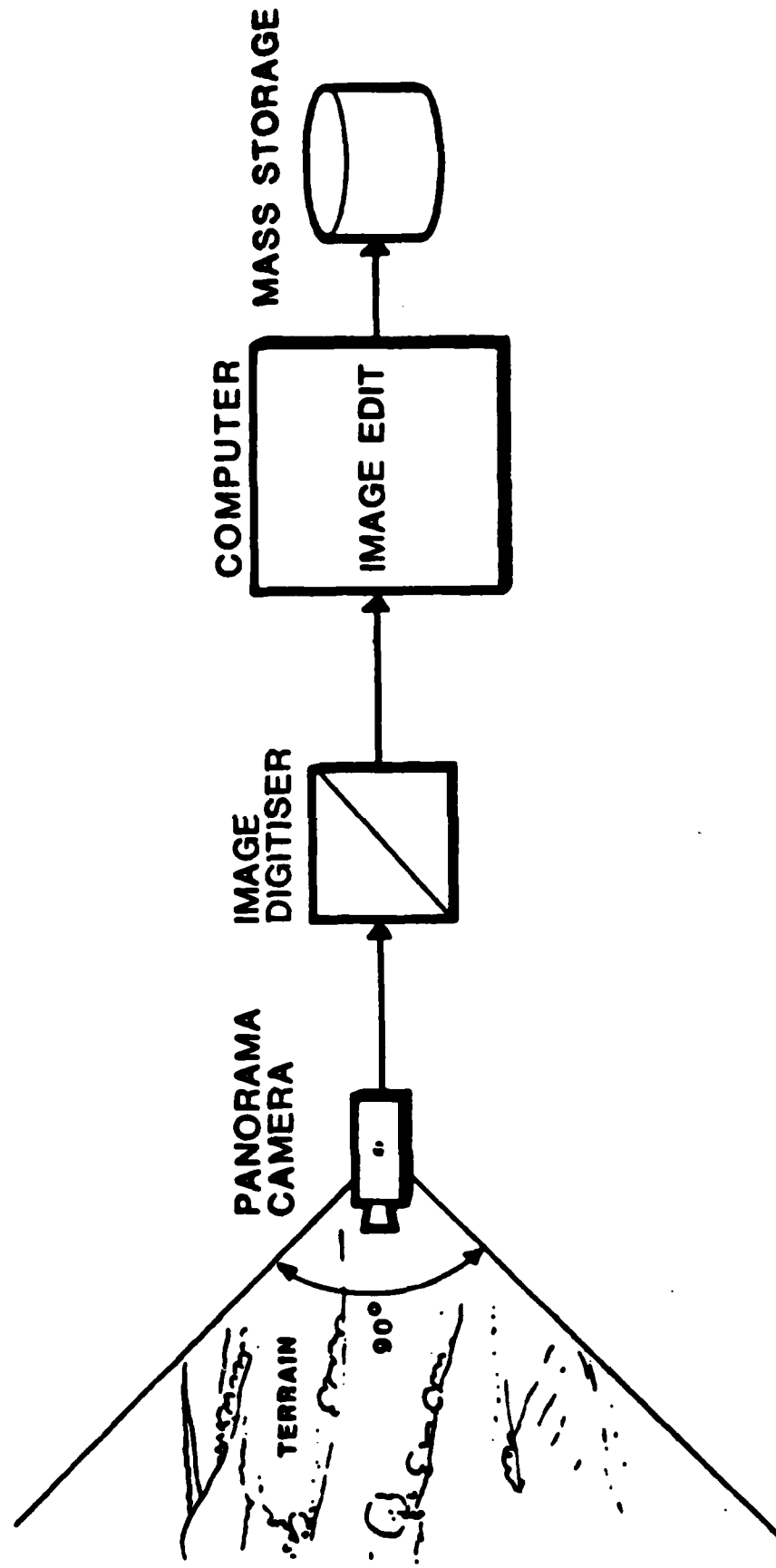
BASIC BLOCK DIAGRAM FOR CSI SYSTEM



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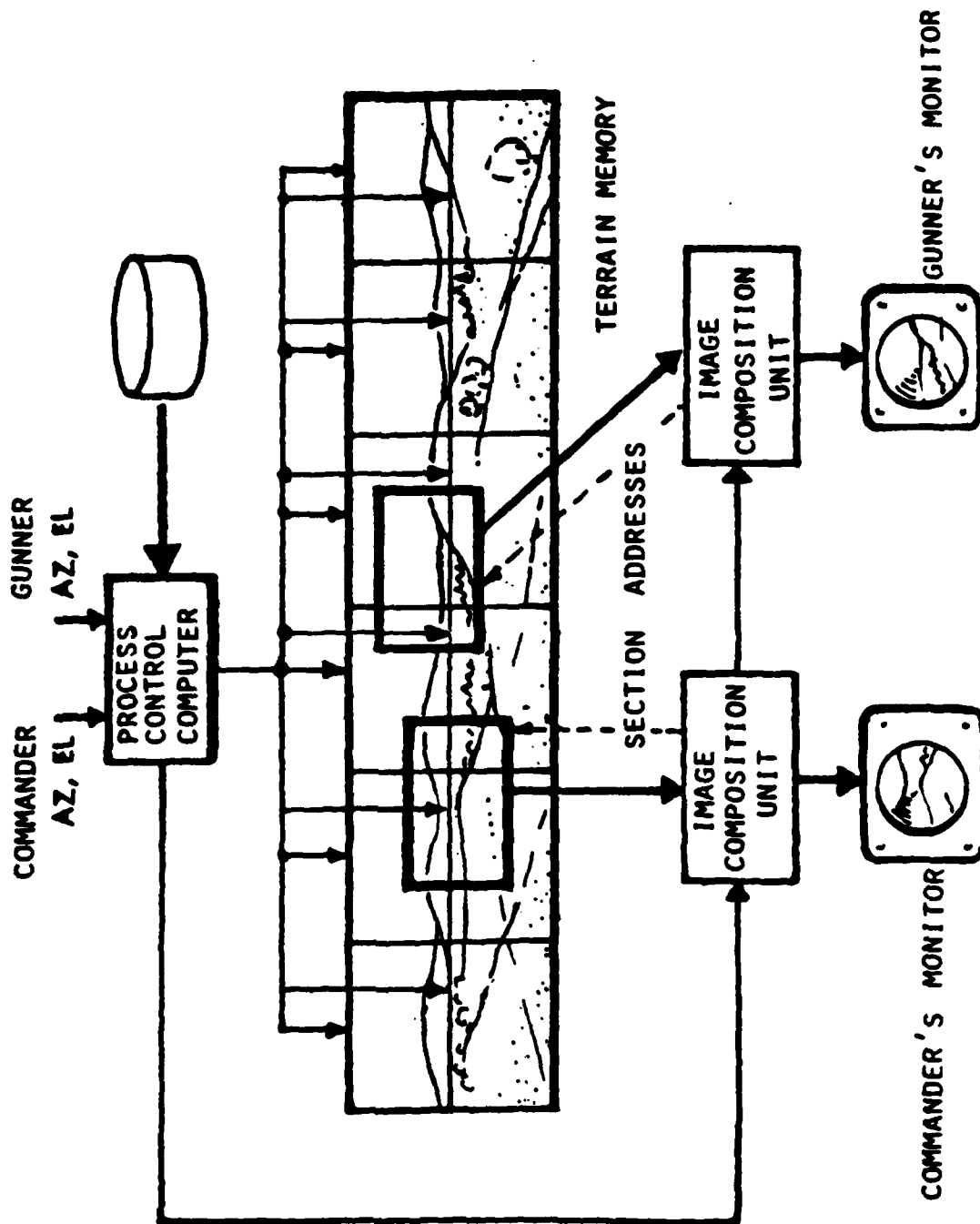
TERRAIN DATABASE GENERATION



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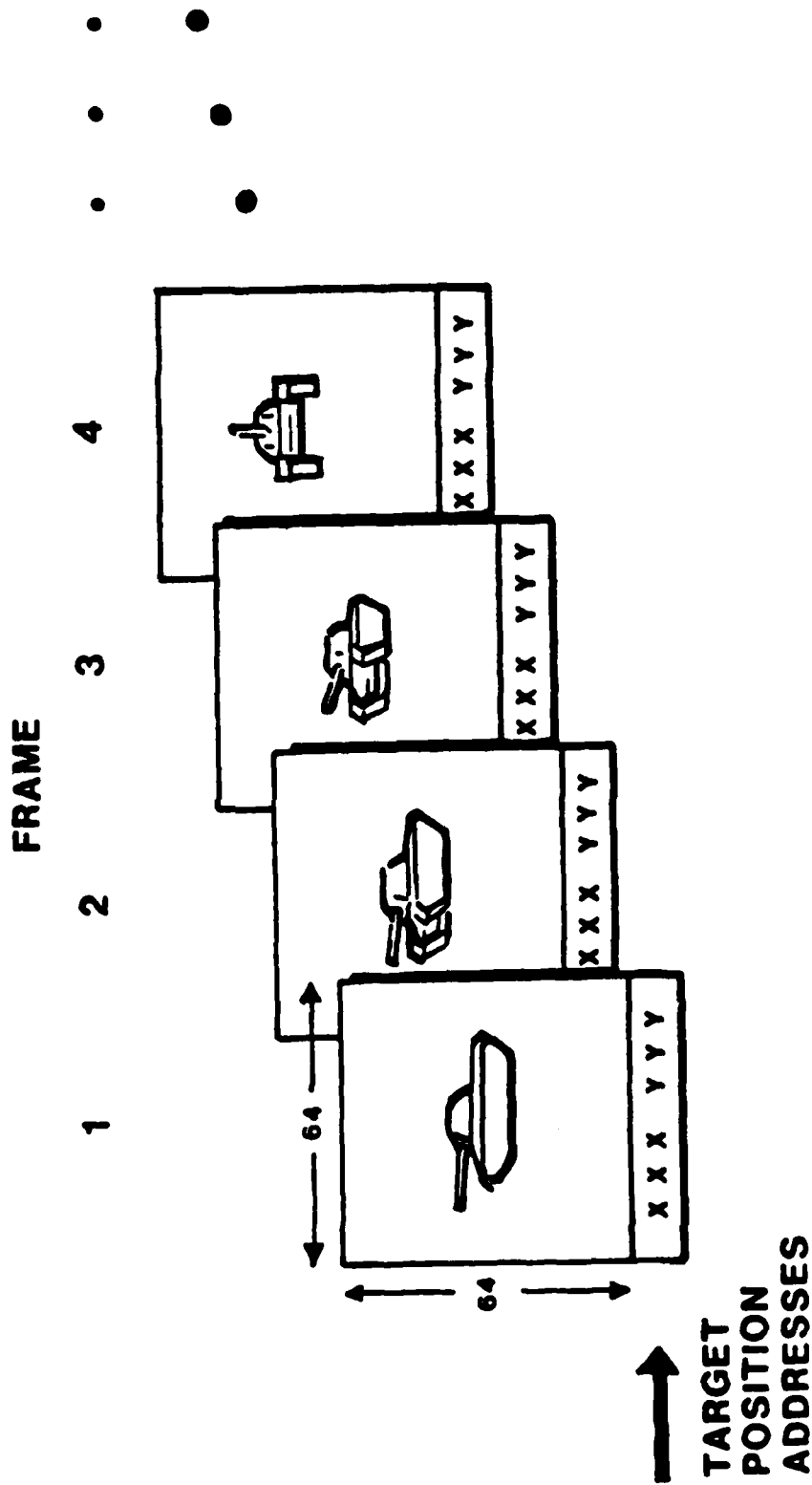
TERRAIN MEMORY



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TARGET MEMORY

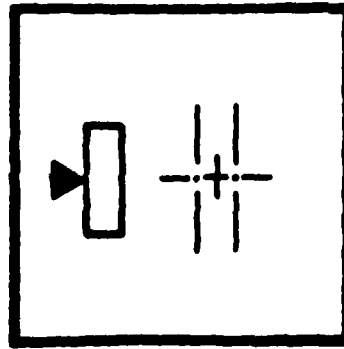




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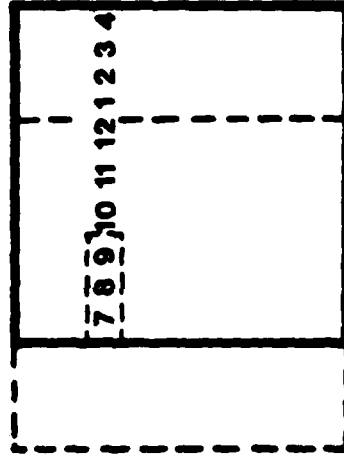


SIGHT RETICLE MEMORY



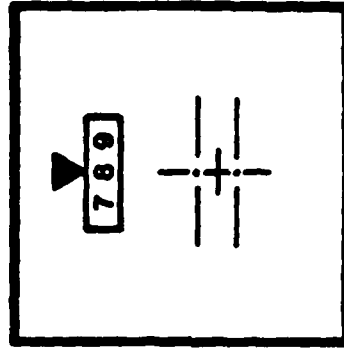
FIXED
RETICLE
PATTERN

+



VARIABLE
RETICLE
PATTERN

=

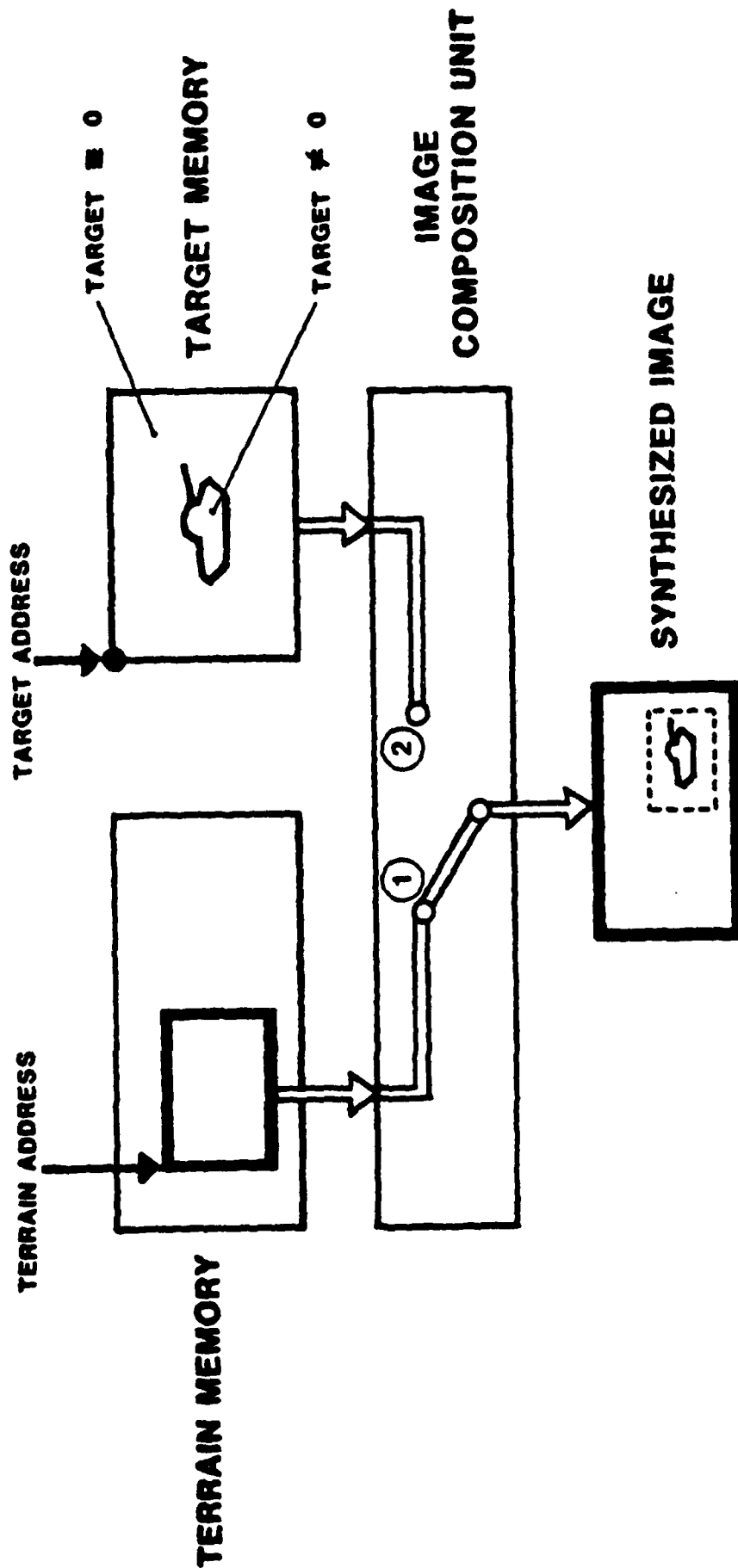


RESULTING
RETICLE
PATTERN

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IMAGE COMPOSITION UNIT

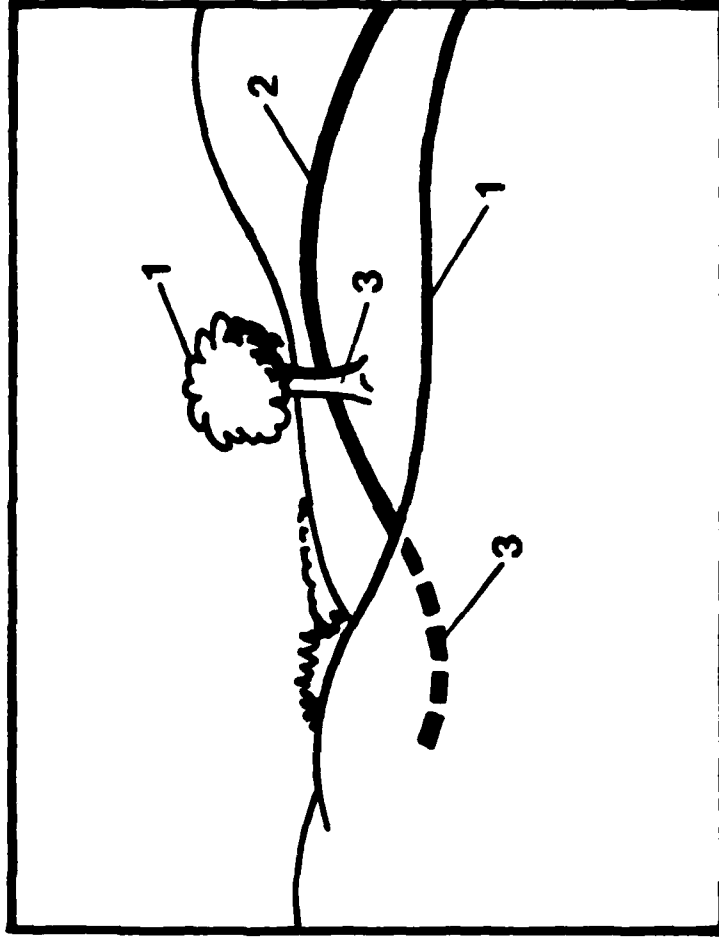


- ① IF TARGET ADDRESS \neq TERRAIN ADDRESS
OR TARGET ADDRESS = TERRAIN ADDRESS BUT TARGET = 0
- ② IF TARGET ADDRESS = TERRAIN ADDRESS AND TARGET \neq 0

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TARGET OBSCURATION LINES



- 1 OBSCURATION LINES
- 2 TARGET TRAJECTORY (VISIBLE)
- 3 TARGET TRAJECTORY (INVISIBLE)

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CSI STATUS AND ENHANCEMENTS (1)

TERRAIN

- **ANY DESIRED BATTLEFIELD TERRAIN** **ACHIEVED**
- **EASILY INTERCHANGEABLE BATTLEFIELD TERRAINS** **ACHIEVED**
- **REALISTIC DAYLIGHT IMAGE** **ACHIEVED**
- **THERMAL IMAGE SIMULATION** **ACHIEVED**
- **WIDE GAMING AREA** **ACHIEVED**
- **VARIOUS MAGNIFICATIONS** **(ACHIEVED)**
- **DAYLIGHT EFFECTS (DUSK / DAWN)** **ACHIEVED**
- **FOG / HAZE** **ACHIEVED**
- **TERRAIN SMOKE**
- **COLOR**
- **OPEN HATCH OBSERVATION**

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CSI STATUS AND ENHANCEMENTS (2)

TARGET

● ANY DESIRED TARGET TYPE	ACHIEVED
● 2 SIMULTANEOUS MOVING TARGETS MINIMUM	ACHIEVED
● REALISTIC DAYLIGHT IMAGE (PERSPECTIVE)	ACHIEVED
● REALISTIC THERMAL IMAGE (CORRECT HOT SPOTS)	ACHIEVED
● REALISTIC TEXTURE	ACHIEVED
● MOVEMENTS IN ALL DEGREES OF FREEDOM	ACHIEVED
● TERRAIN / TARGET MASKING	ACHIEVED
● MUZZLE FLASH AND GUN SMOKE	
● DUST CLOUD	
● CUSTOMER GENERATED TARGET COURSES	
● VARIABLE TARGET SPEED	

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CSI STATUS AND ENHANCEMENTS (3)

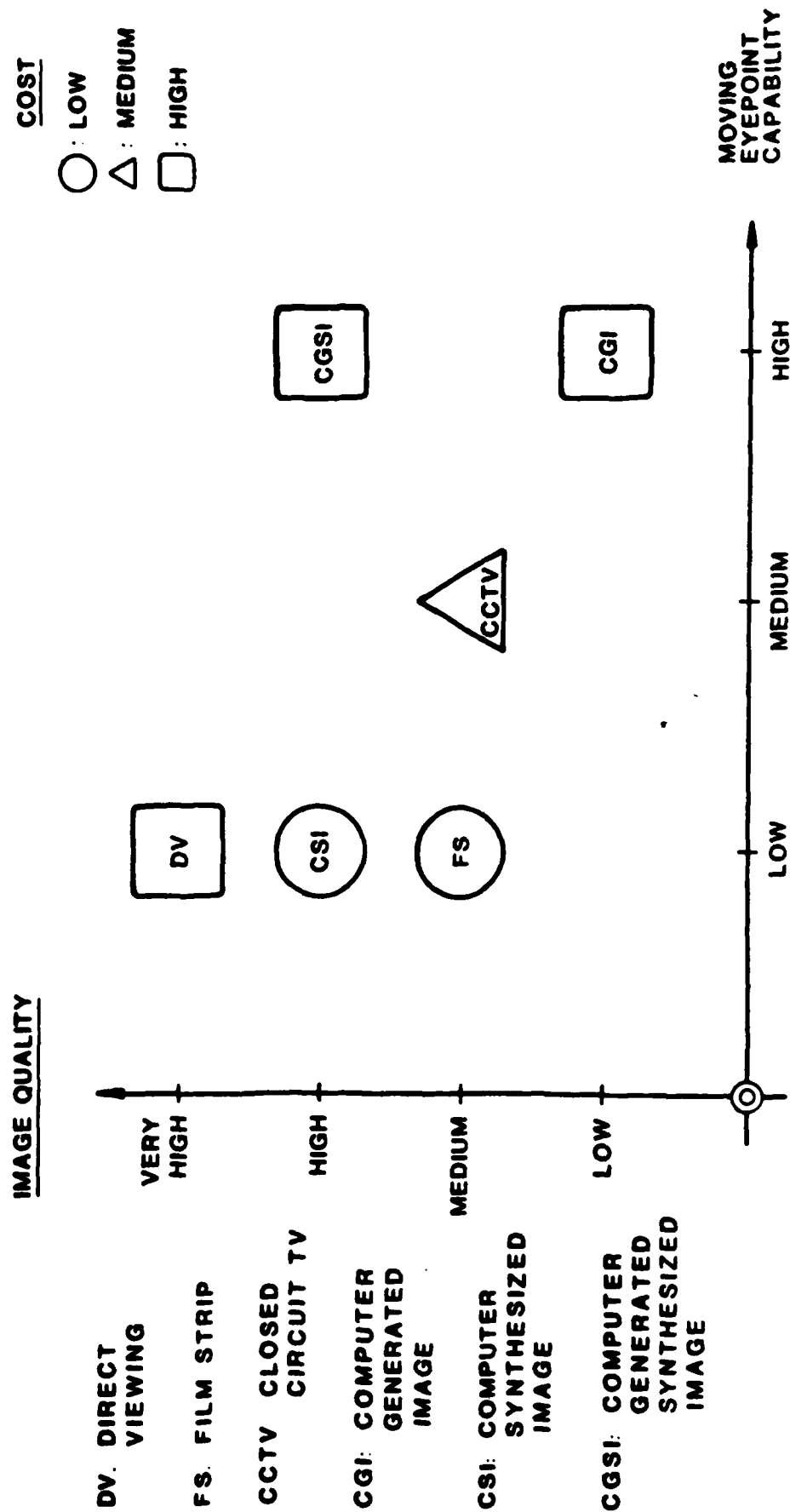
SYSTEM

- **SIGHT RETICLE PATTERN (FIXED / MOVING)** **ACHIEVED**
- **OWN DRIVING EFFECTS** **(ACHIEVED)**
- **GUN SMOKE** **ACHIEVED**
- **TRACER TRAJECTORY** **ACHIEVED**
- **HIT FLASH** **ACHIEVED**
- **RICOCHET** **ACHIEVED**
- **TERRAIN HIT / DUST CLOUD** **(ACHIEVED)**
- **LASER SIMULATION WITH MULTIPLE RETURNS** **(ACHIEVED)**
- **SIMULATION OF COINCIDENCE RANGE FINDER**
- **SIMULATION OF STEREOSCOPIC RANGE FINDER**

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VISUAL SIMULATION COMPARISON



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TROUP TEST

● SCHEDULE 1/83 - 12/83

● OBJECTIVES

- TO PROVE APPLICABILITY OF TRAINING
- TO DEMONSTRATE TRAINING EFFECTIVITY
- TO DEVELOP A SIMULATOR SUPPORTED
TRAINING CONCEPT
- TO IMPROVE TRAINING COST REDUCTION
- TO VERIFY STUDENT'S CAPABILITY
ENHANCEMENT



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SONDERTECHNIK

**HONEYWELL GMBH
SONDERTECHNIK
HONEYWELLSTR.
D 6457 MAINTAL 1
TEL. 06181-401(1)
TELEX 4184820**

DYNAMIC MODEL

1. GENERAL

1.1 General Description and Arrangement

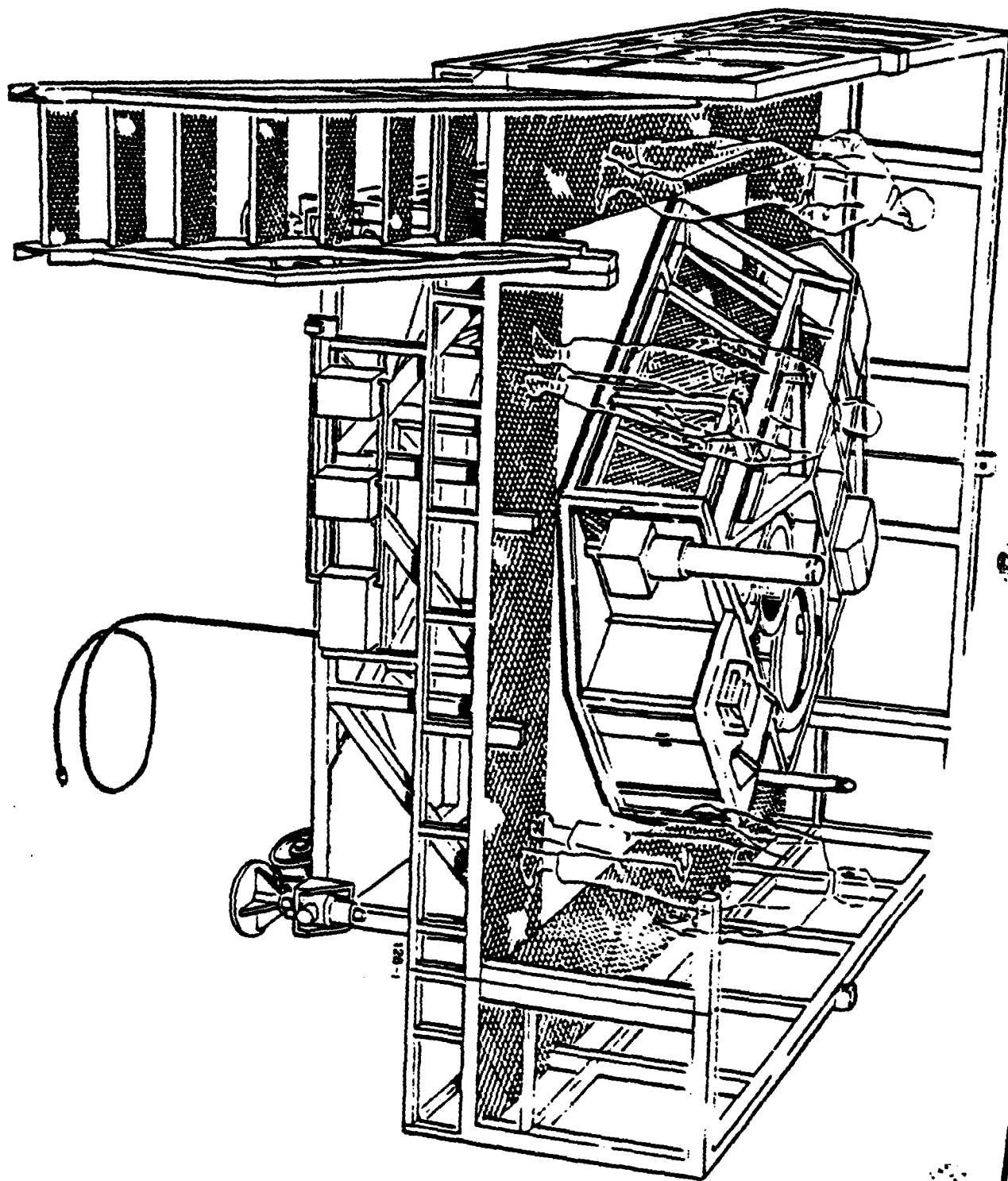
1.1.1 Device description

a. The M1 Tank Turret Organizational Maintenance Trainer (TTOMT) shall be a three-dimensional rotating mockup of the M1 tank turret, with an instructor's control station mounted immediately behind on the same rotating platform as the turret. The 105mm gun muzzle shall not be fully simulated; only a stub shall be simulated on the outside of the turret so that no danger to trainees shall exist while the turret is rotating. On the inside of the turret, however, the gun shall be simulated as much as is necessary under guidelines in paragraph 2.3 of this report. The mockup turret shall be supported by a stand that shall also support a viewing platform at the level of the actual tank-turret interface. The mockup turret shall be enclosed by an expanded metal meshwork, thus providing visibility. Figure 1 shows the TTOMT.

The TTOMT shall enable mechanic trainees to become proficient in maintaining the M1 turret. The device layout (fig 1) shall allow the instructor and student to use trainer controls and indicators as in the actual vehicle. Trainer use shall allow effective and efficient demonstration to a maximum of 15 students and individualized practice and testing for related subsystem troubleshooting procedures. A speaker shall allow audible cues to be heard by the students.

b. Malfunctions shall be inserted easily and quickly by using master console keys. The aural device shall provide appropriate audio cues to support the malfunction symptom. The device shall monitor trainee progress for proper sequence of task actions and elapsed time. Upon completing a malfunction, the trainer printer shall provide a performance score to the instructor for his evaluation and subsequent action. The printer shall be a quiet device located inside the instructor's station and providing the instructor with a privileged display of information.

Figure 1. M1 Tank Turret Organizational Maintenance Trainer (TTOMT)



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c. Malfunctions may be selected by the instructor using master console keys. One malfunction at a time may be entered into the trainer, from a list of fifty (50) available.

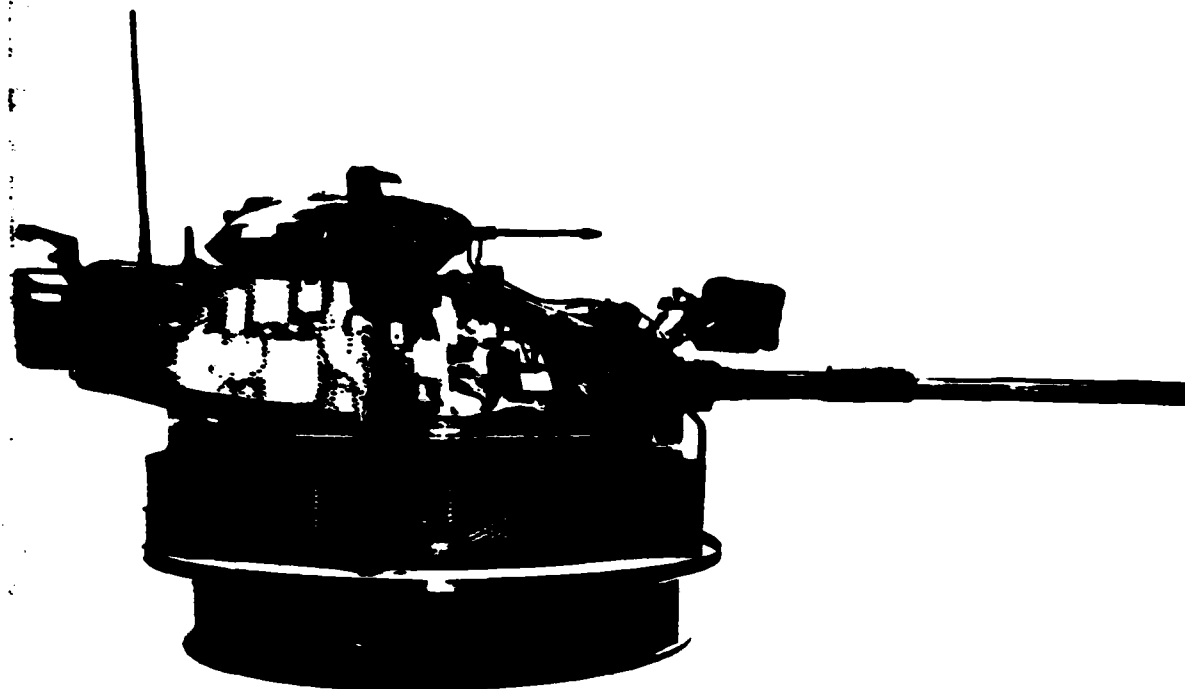
1.1.2 Overall dimensions

- a. Length: 16 ft., 6 in. (503cm).
- b. Height: 9 ft., 2 in. (277cm).
- c. Depth: 23 ft., 1 in. (705cm).
- d. Weight: 15,280 lbs. (6930kg).

TRAINER, TANK GUNNERY: 105MM

DVC 17-62
M30A1

NSN 6920-00-181-8785



DVC NO. 17-62

Training Category/Level Utilized:
Armor/Level 1

Logistic Responsible Command, Service, or Agency:
ARRCOM

Source and Method of Obtaining:
Not generally available for issue (limited production).

Purpose of Trainer:
The trainer is for classroom use to familiarize personnel with operation and maintenance of the M60A1 Tank Turret. The specific training requirements supported are shown following the descriptive data.

Functional Description:

The M30A1 Tank Gunnery Trainer is an instructional aid to train personnel in the operation and maintenance of the M60A1 Tank Turret, 105mm Gun with Add-On-Stabilization, .50 Caliber Machinegun, 7.62mm Machinegun coaxially mounted, and associated sighting and fire control equipment. The trainer is fully equipped with M60A1 Turret components, including on-equipment materiel. Casters provide for trainer mobility in classroom area. Cutouts in the turret wall allow instructors to observe operations from the platform on the turret stand.

Electric power for turret operation is furnished by a rectifier powerpack, which replaces the conventional tank electrical power source. Hydraulic power for

DA Pam 310-12

raising the trainer is provided by three manually-operated pumps mounted on the stand assembly.

Physical Information:

313"x 115" x 118"; 36,000 lb

Equipment Required, Not Supplied:

None

Special Installation Requirements:

None

Power Requirements:

Rectifier 230/460 volts, 3-phase, 50/60 cycles, output voltage 25-31 vdc, with maximum continuous current of 400 A, and maximum current intermittent for 3 minutes 800 A

Applicable Publications:

Commercial Handbook of Operation and Maintenance Guidelines

Reference Publications:

TM 9-2350-215 Series

TM 9-2300-378 Series

TM 9-1000-213 Series

Training Requirements Supported:

FM 17-19E1/2, FM 17-19E3, and FM 17-19F1/2

SM 171-123 Tasks

1202 1203

SM 171-124 Tasks

2051 2052 2055

SM 171-127 Tasks

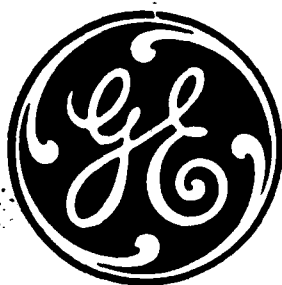
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1009	1013	1216	2058
1010	1014	1233	2059
1011	1015	2056	

SM 171-132 Tasks

1201 1202 1203 1204

SM 171-139 Tasks

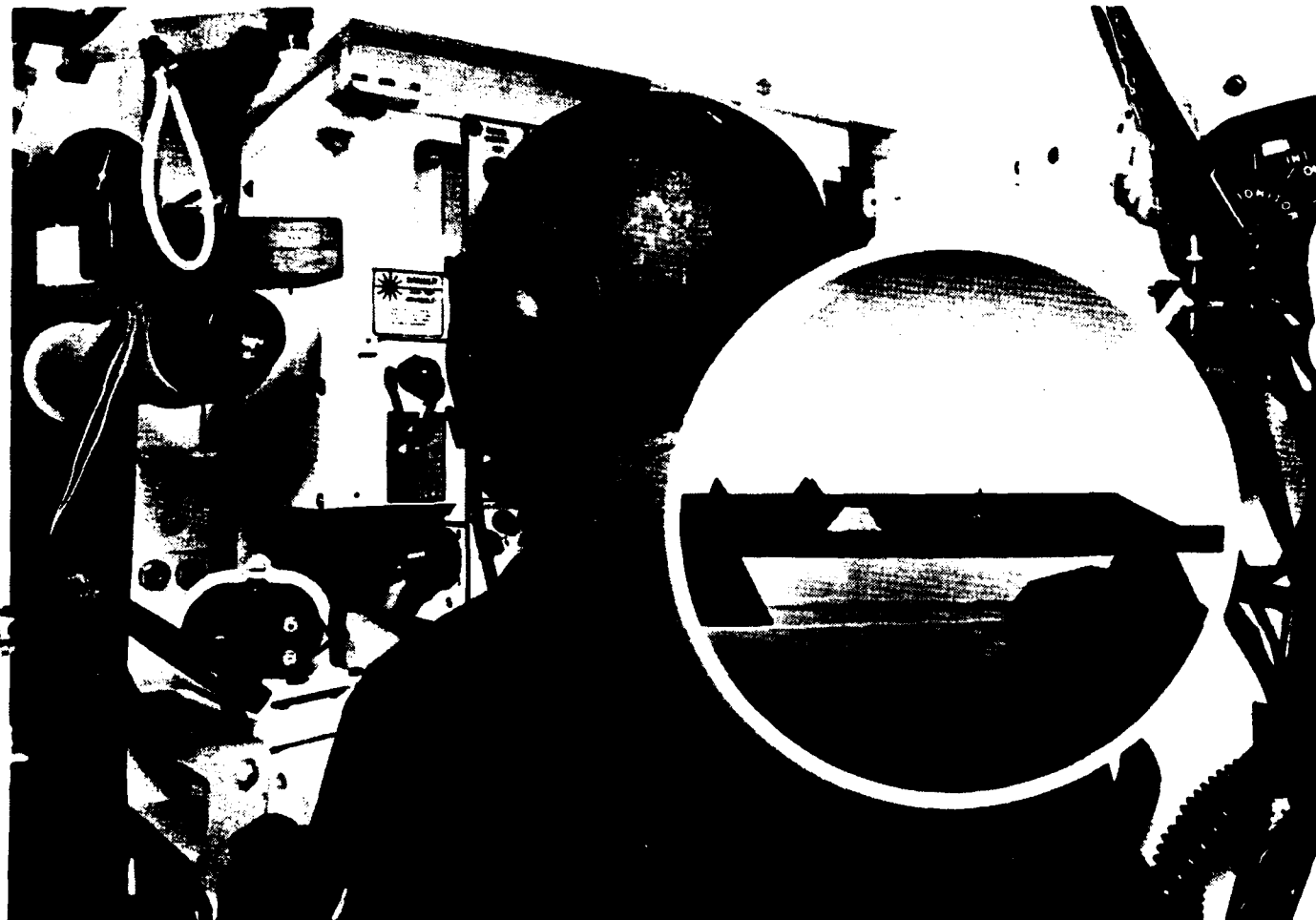
1007	1017	1026	1031
1009	1018	1027	1033
1010	1023	1029	1040
1012	1024	1030	1045
1016			



Conduct of Fire Trainer (COFT)

SCSD PRODUCT PROFILE

SIMULATION SYSTEMS



Computer-Generated Imagery highlights the ability of the Conduct Of Fire Trainer to represent modern tanks and their fire control systems.

Simulators offer a state-of-the-art solution for easing the heavy demands on diminishing fuel resources and for eliminating the cost and hazard of live ammunition for gunnery training. Fuel is expensive and practice ammunition is costly. This is no less true for surface combat vehicles such as tanks than for military aircraft, ships, and submarines. Tanks can be ravenous when it comes to fuel consumption. And lack of maneuvering space is often a barrier to real world training exercises, particularly gunnery.

As weapons systems become more expensive and more lethal, practice with actual weapons will become even more limited. Tanks, traditionally used both operationally and for training, will in-

creasingly be supported in the training role by simulators. Simulators can play a major role in developing combat-ready tank crews to meet any major military confrontation.

The General Electric Conduct of Fire Trainer (COFT) is a deployable, shelterized gunnery simulator which uses computer-based visual simulation technology to create an environment that is ideal for learning. The COFT produces full-color computer-generated action scenes in which tank crewmembers can see and interact with dynamic multiple target situations. Yet, there is no danger to the crew, no fuel is consumed, and no ammunition is expended. In addition to saving fuel and ammunition costs, the COFT has other advantages:

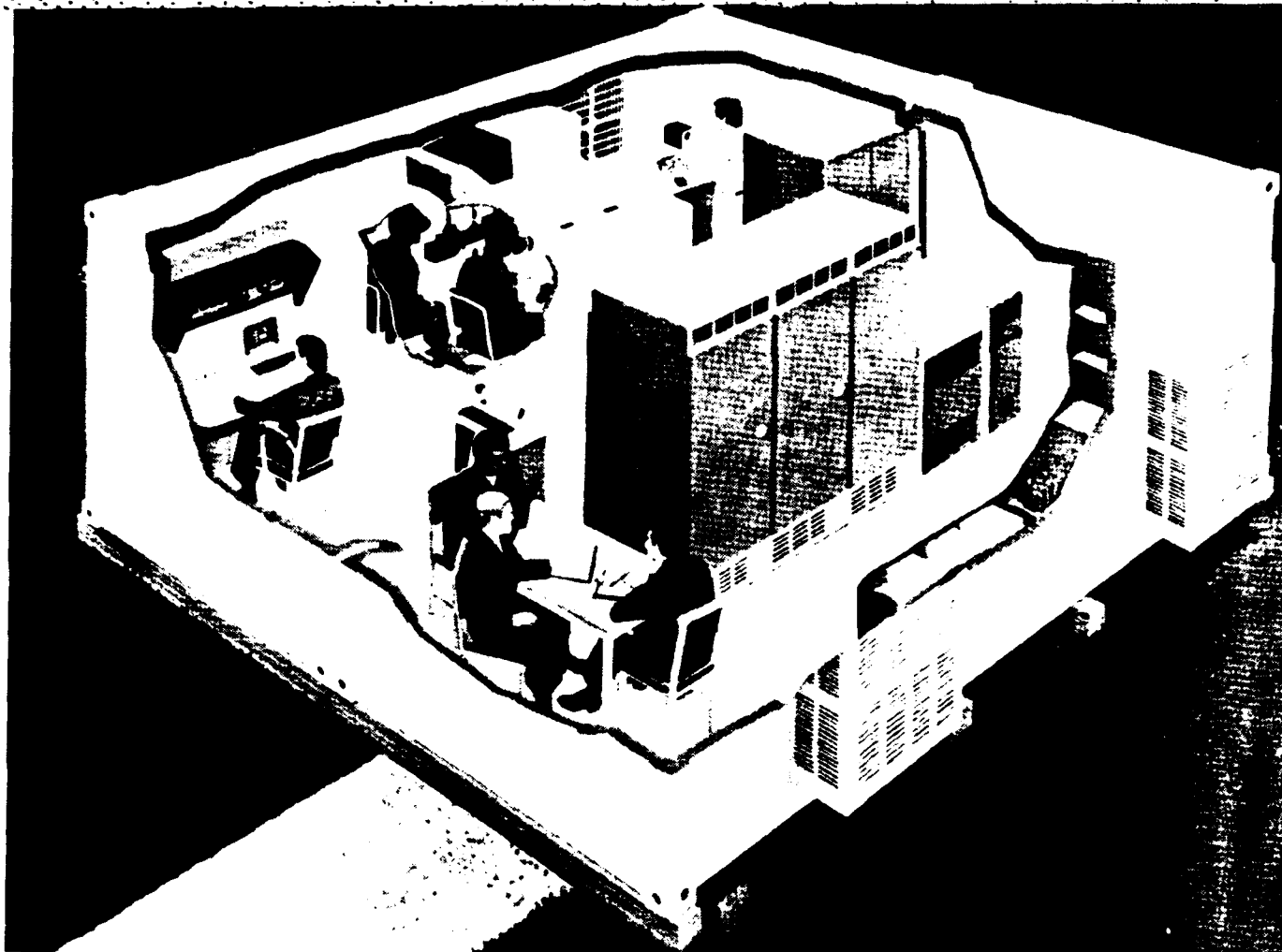
- It can be used 24 hours per day, every day,
- weather can be scheduled in the simulator,
- simulated engagements can be re-enacted, and
- degraded modes of operation can be practiced.

The COFT allows more tanks to be kept where they should be: ready for any emergency.

COFT systems are currently configured to represent the M1, M2 and M3 fighting vehicle systems, M60A1, and M60A3. In June, 1981, the first M1 COFT started field test by the U.S. Army at Fort Hood, Texas. The first M2 will begin test in September 1981.

GENERAL ELECTRIC





Deployable COFT system in Basic Mobile Facility Housing

Crew Compartment

In the shelterized COFT there are training stations for the tank commander and for the gunner. Like the M1, the COFT's computer-stabilized fire control system supports accurate firing while the simulated tank is on the move. To enhance the realism of the training exercises, the

all realistically simulated. Audible effects include engine and drive train whine, tread clatter, clank of the breech block, as well as gun firing and the sound of spent brass falling on the deck.

Visual Simulation

The COFT uses computer-generated images to represent the scenes viewed by crewmembers training in the simulator. The special purpose computer image generator provides full-color, dynamic, daylight and nighttime scenes with various terrain and topographical backgrounds, man-made structures, moving targets, shell trajectories, and special effects that allow tank crews to develop gunnery proficiency in a broad range of simulated battle conditions. Correct visual perspective is instantaneously computed and maintained for all orientations of the tank relative to its targets. The "own-tank" can move freely within the data-base, allowing full simulation of tank tactics.

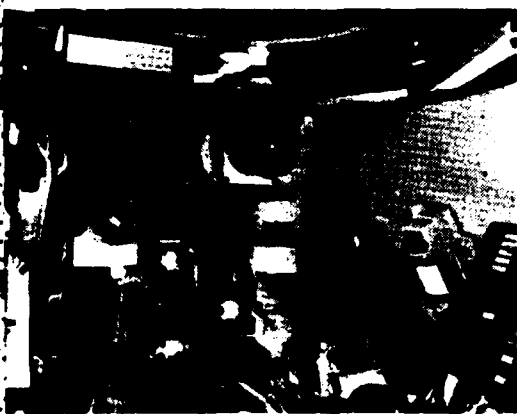
The visual subsystem presents views under normal and degraded visibility conditions, and with detail appropriate to the magnification of the sight being used. When simulating the tank's Thermal Imaging System (TIS) mode, a special infra-red processing algorithm and electronic noise effects are introduced

to closely represent actual sight performance. The simulated TIS mode can be used not only for night vision exercises but also for detecting and attacking targets in daytime that are camouflaged by fog or smoke.

The COFT generates its views from a digital data base with data retrieved under digital computer control. The retrieved data covers a 10,000 by 7,000 meter exercise area within the immediate viewing range of the tank. Special-purpose hardware computes the scenes point-by-point and scan line-by-scan line based on the geometry of the viewing situation. When the simulated vehicle moves, the magnification changes or the periscope slews, the scene changes just as it would in the real tank's viewing system.

Gunnery Simulation

Computer-generated weaponry effects highlight the ability of the COFT to represent flexible and programmable battle situations in real time. Operators of the simulator can learn to maximize hit probability, especially in situations where the first round may be the only round fired. In fact, first round hits at ranges to several thousand meters can be made consistently in the COFT and in the M1 when crewmen are trained to use the



crew station faithfully reproduces the appearance and functions of the tank's operating controls, indicators, and weapon sights. Characteristics such as appropriate diopter adjustment, exit pupil, optical transmission properties, field of view, magnification selection, sight reticles, and filter/shutter appearance are



An instructor at the instructor/operator station controls training exercise and evaluates performance.



Computer-generated imagery simulates the tank's thermal imaging system.

full capabilities of the M1's sophisticated fire control system. The main gun and machine gun simulation features an inexhaustible supply of ammunition with realistic portrayal of tracer rounds and projectile impact. Recoil effects are provided by motion imparted to the gun brow pads when the main gun is fired. Accurate ballistic simulation is provided for own-weapon and threat-weapon trajectories, with realistic visual effects for target motion, obscuration, tracer, smoke grenade, hit, kill, and miss conditions.

Weapons simulated by the current COFT configuration include:

- 105 mm main gun
- 25 mm main gun
- 7.62 mm coaxial machine gun
- 50 cal machine gun
- TOW (Tube-launched, Optically tracked, Wire-guided) missile system
- Smoke grenade

Instruction

An instructor at the instructor/operator station (IOS) controls training exercises and evaluates performance. Full-color video displays are provided at the IOS so that the instructor can simultaneously view the same scenes presented to the tank commander and gunner. The IOS incorporates a keyboard terminal and display system to initiate, control, and monitor the activities of the tank commander and gunner. Trainee performance, principally accuracy and response time, are measured and displayed at the IOS. An intercom system allows the instructor to communicate with the trainees and to simulate radio transmissions. Simulated malfunctions can be inserted into the training situations.

A library of preprogrammed exercises can be loaded and executed from the IOS. The library currently consists of over 200 exercises with as many as four

different versions of each exercise. The exercises depict different terrain conditions: typically woods, hills, flat plains, and desert areas. Each version of a given exercise differs in scene content and order of target presentation. Exercises are ranked in difficulty and scored along three skill dimensions: target acquisition difficulty, systems management difficulty, and reticle aiming difficulty. The successful engagement of an enemy combat vehicle, for example, depends on the achievement of three separate functions: (1) the detection and acquisition of the hostile vehicle, (2) the selection and initialization of the weapon, and (3) the aiming and firing of the weapon.

The difficulty of tasks presented to the trainee is adaptive, that is, the general-purpose computer selects subsequent training scenarios on the basis of trainee performance, the instructor having the freedom to override the selection if he wishes. The more difficult exercises include long range multiple targets moving at erratic high speed, some with degraded visibility conditions.

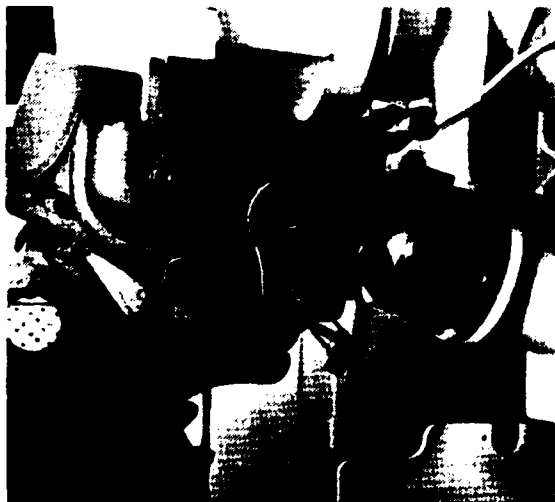
Computer Subsystem

You have to look beyond the crew compartment to see that there's much more to the COFT system than what meets your eye from the tank commander's or gunner's positions. Control of the COFT system, for example, is done by a general purpose computer which interfaces with the crew compartment, IOS, visual subsystem, and the environment data base. It carries out the following functions.

- Controls Data Flow
- Controls Moving Targets
- Provides Computer-Aided Diagnostics
- Calculates Ballistic Equations
- Calculates Aimpoint Errors
- Monitors Crew Responses
- Performs Training Management Functions (Recommends exercise sequence, prepares hard copy performance record and also maintains complete past history files on each crew)

The computer is a 32-bit machine with disc memory, CRT terminal, and keyboard. Real-time operational software, test and maintenance software, and support software make up the computer program system.

The programmable nature of the COFT design makes it adaptable to represent any tank's performance characteristics, and instruction can range from basic gunnery training up to force-on-force combat training. Trainee performance evaluation and documentation of exercise results are included in the COFT instructional system.

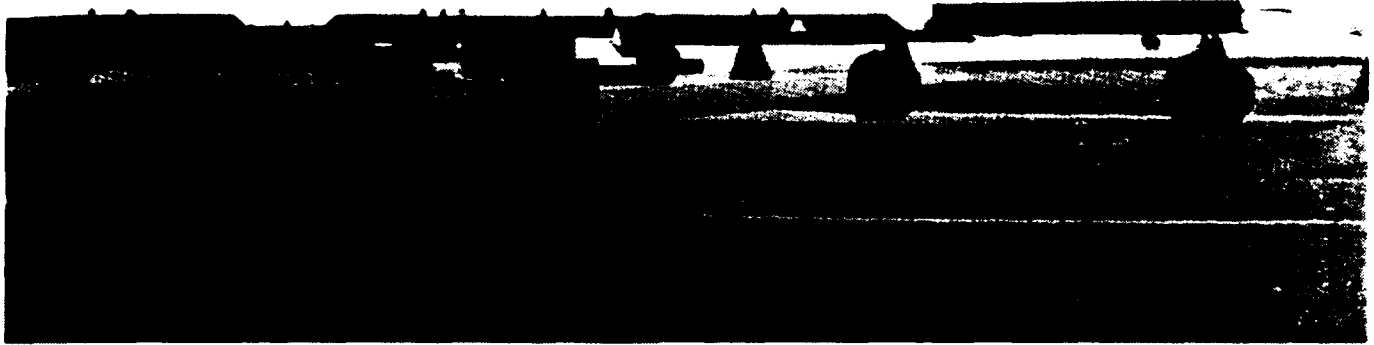


Training Capabilities

By simulating a wide variety of situations and tactical engagements, the COFT system can provide basic gunnery training and keep fully qualified crews proficient. A library of preprogrammed exercises is provided which

can be loaded and executed from the instructor station. A training sequence should typically progress from identifying a target, to setting up the weapons system, to aiming the reticle and firing the simulated weapon.

The COFT system will simulate different times of day or night, including dawn and dusk. Simulated special effects include scud, rain, smoke, variable fog, and fading to further increase scene realism.



Instructional Features

- **Problem Freeze**—The instructor can halt an exercise, causing the visual scene to remain stationary and all controls and indicators to remain in their current state.
- **Problem Record/Playback**—Up to 15 minutes of an exercise can be reenacted for subsequent playback during a trainee critique.
- **Problem Difficulty Control**—There are instructor-controlled exercise conditions in each of four skill areas: target acquisition, reticle aiming, system management, and crew coordination training.
- **Malfunctions Simulation**—Trainees can be taught to adapt quickly to failed mechanisms and to assess, react to, and compensate for malfunctions that can be caused by battle damage.
- **Records Keeping**—Hard copy performance summaries are provided at the end of a training session and past history files are available for each crew.
- **Target Presentations**—Anywhere within the range of 200 to 4000 meters.
- **Owntank Motion**—No limit within the exercise area.
- **Target Vehicle Motion**—Up to four active targets in the scene; as many as 20 active targets in an exercise. Preprogrammed paths.
- **Laser Ranging**—Accurate to within ± 10 meters of the true location of objects in the visual scene.
- **Visibility Effects**—Night and smoke simulation can be used to make target acquisition, reticle aiming, and system management training more difficult.
- **Ballistic Equation Computation**—Exterior ballistics are computed based on slant range and cross wind velocity. Aimpoint computation compares ideal gun angles necessary to hit active targets against actual gun angles to determine reticle lay error. The effect of round-to-round dispersion is also simulated.
- **Gunnery Skills Development**
 - ☐ Target Acquisition
 - ☐ Reticle Aiming
 - ☐ Systems Management (correct ammunition, switch sequencing, engagement of targets in order from most dangerous to least dangerous, etc.)
 - ☐ Crew Coordination
- **Gunfire Effects**
 - ☐ Enemy Tank and Artillery Fire. White flash, orange fireball, sparks and/or kicked up earth depending upon the type of ammunition and the point of impact.
 - ☐ Tracers. Will extinguish whenever collision with target or terrain occurs, or when burnout range is exceeded.
 - ☐ Impact on Target. Target will stop when hit by owntank fire.
 - ☐ Hit on Owntank. Bright flash and obscured visual scene.
 - ☐ Smoke Grenade. Obscures the visual scene for about two minutes.

The information contained in this publication is for guidance only. Individual system specifica-

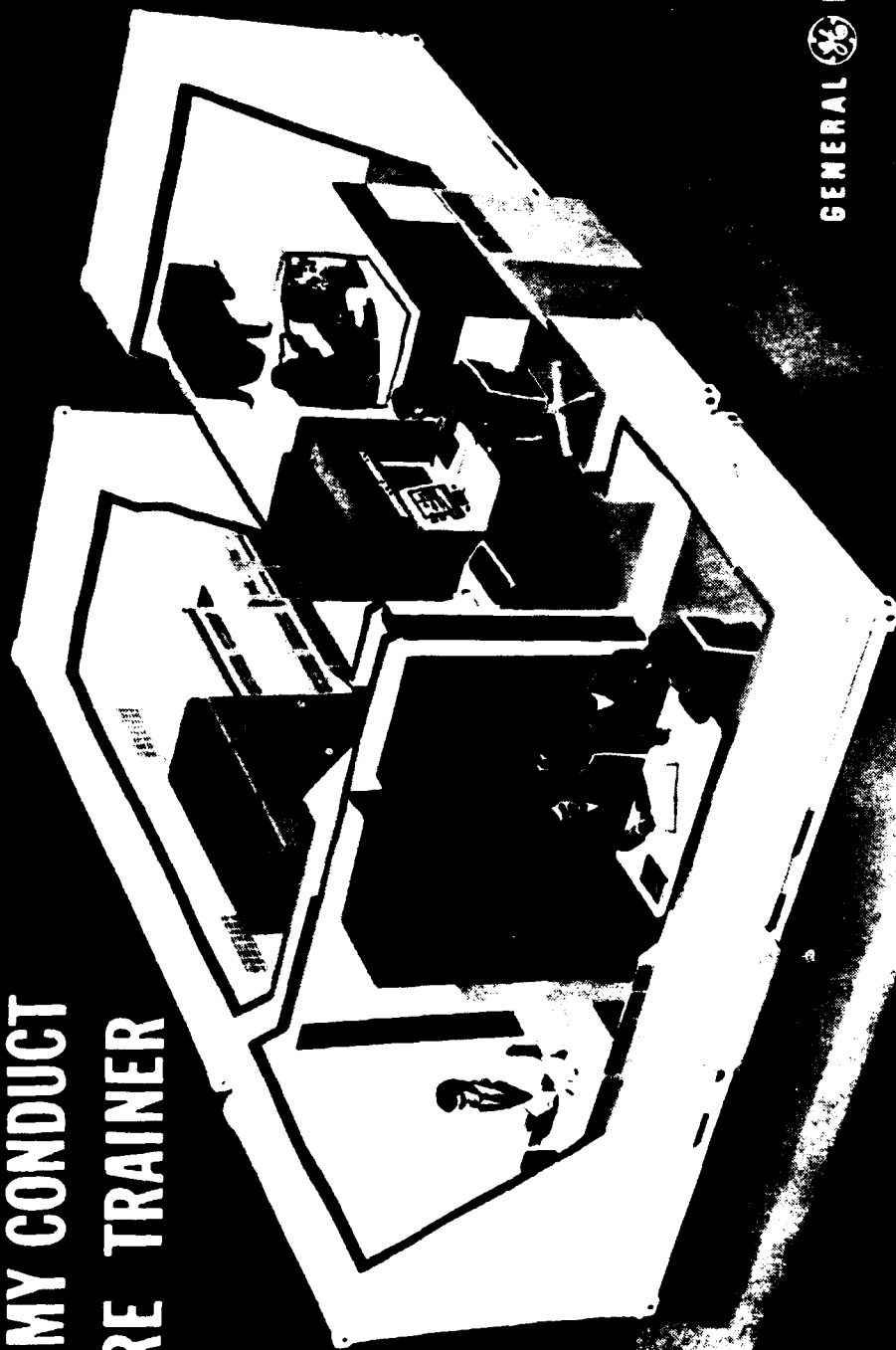
tions are tailored to customer requirements. For definitive data please refer to the appropriate

proposal or contract specification.

GENERAL  ELECTRIC
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GENERAL ELECTRIC COMPANY
SIMULATION AND CONTROL
SYSTEMS DEPARTMENT
ELECTRONIC SYSTEMS DIVISION
P.O. BOX 2500
DAYTONA BEACH, FLORIDA 32015

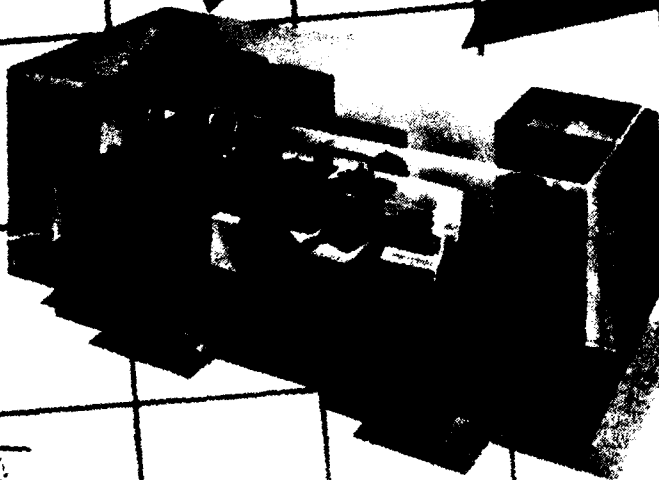
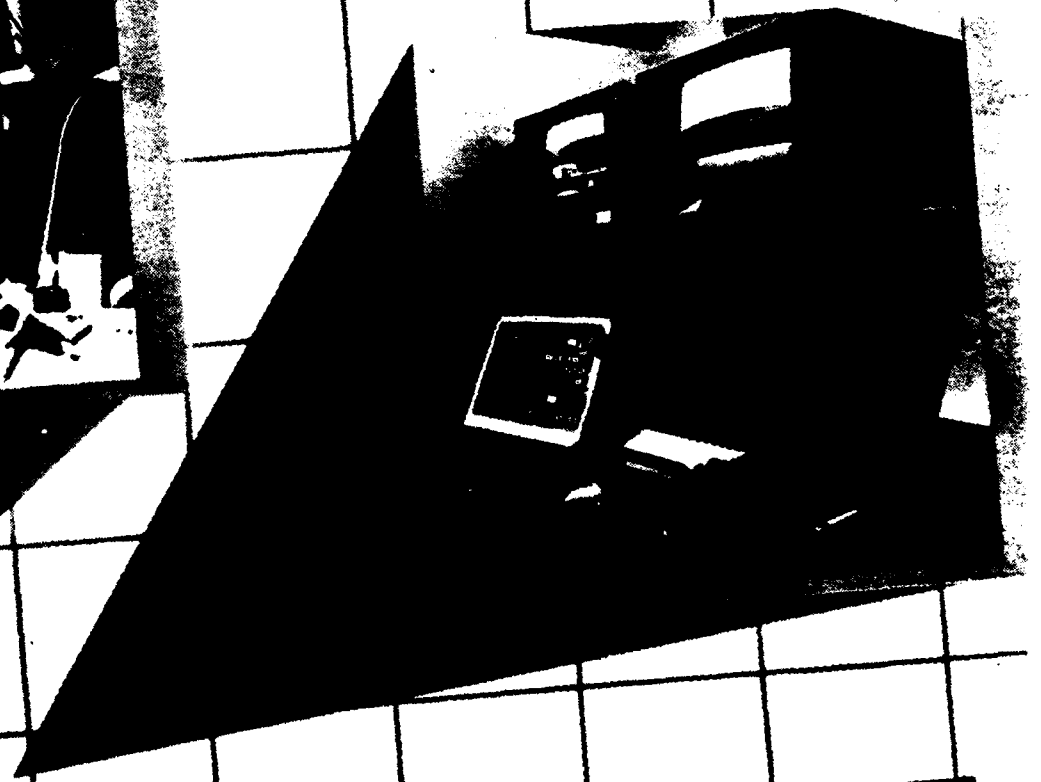
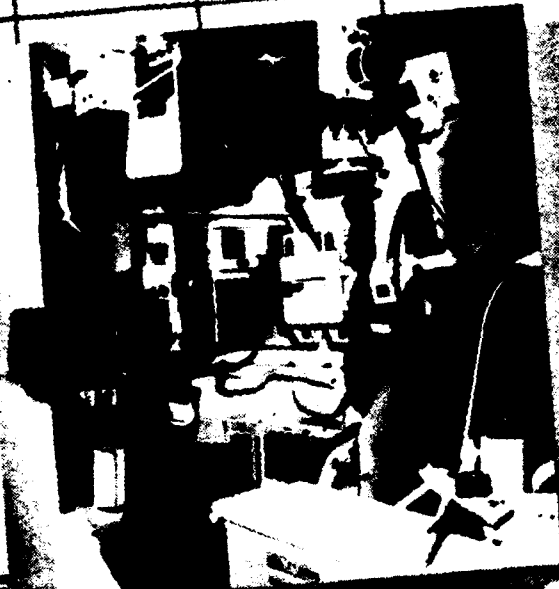
U.S. ARMY CONDUCT OF FIRE TRAINER



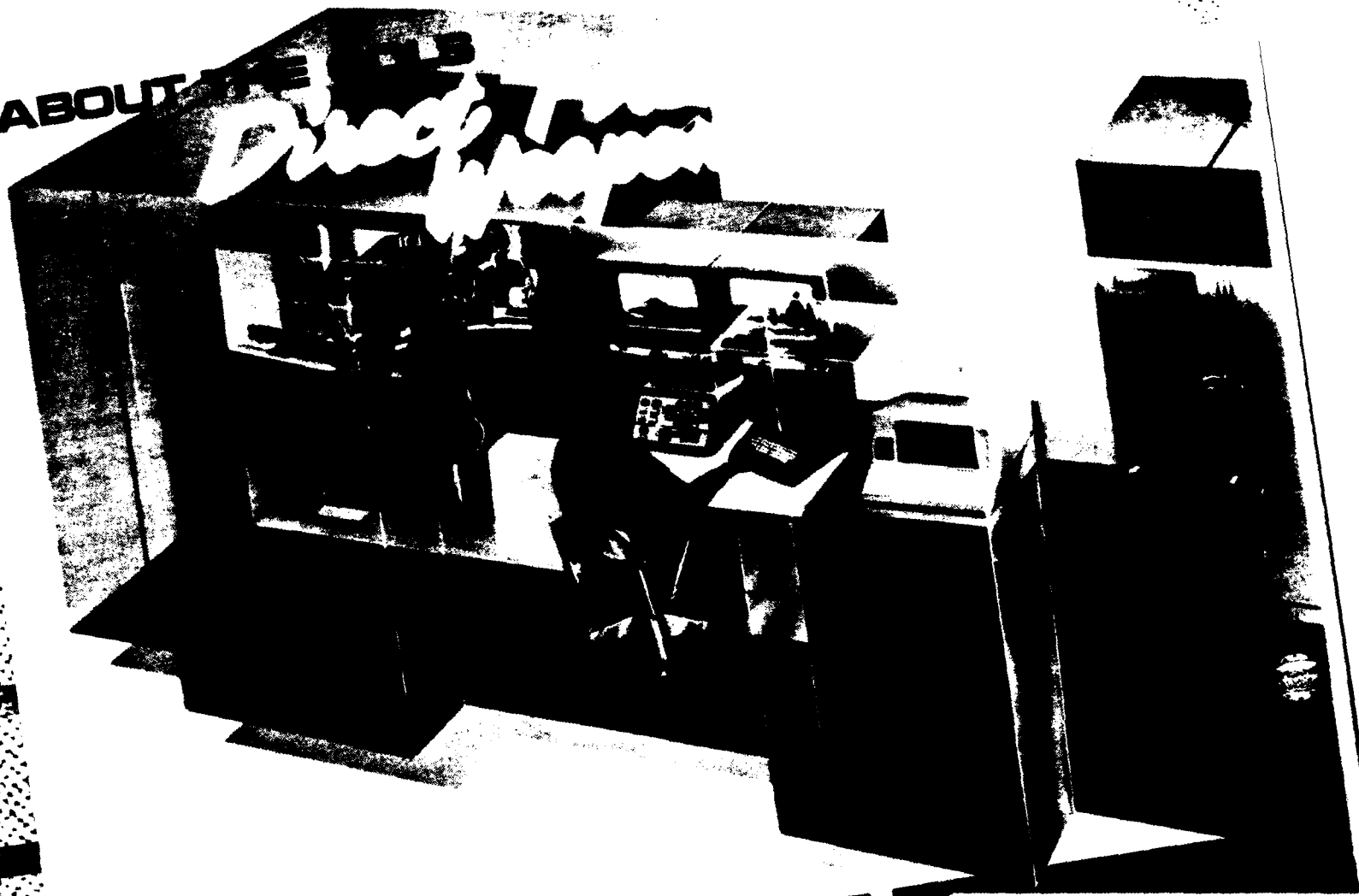
GENERAL  ELECTRIC

GENERAL DYNAMICS
Land Systems Division

Direct Fire Weapons Trainer



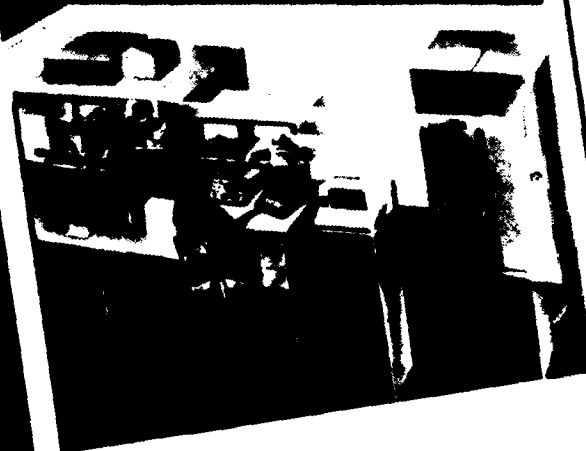
ABOUT THE F-15 Direct Fire Trainer



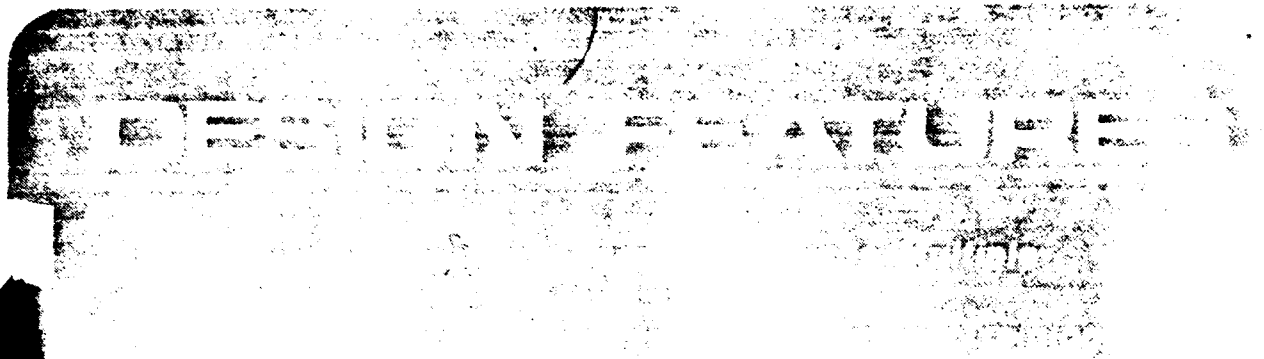
DEVELOPED TO SUPPORT M1
MAIN GUN FIRE CONTROL
SYSTEM DEVELOPMENT - USED
FOR TRAINING 1993 CANADIAN
CUP COMPETITION CREWS.



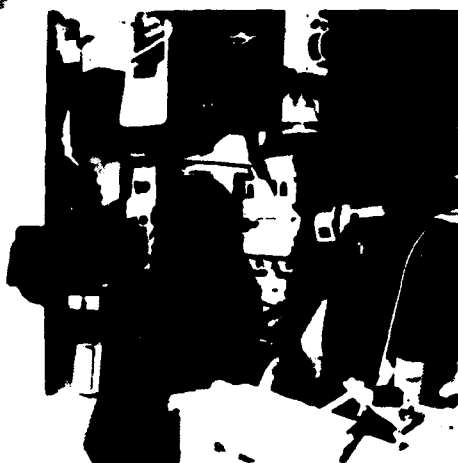
DEVELOPED TO PROVIDE AN
AFFORDABLE CGI SCENARIO
WITH BUILT-IN-TEST AND
EVALUATION OF CREW SKILLS



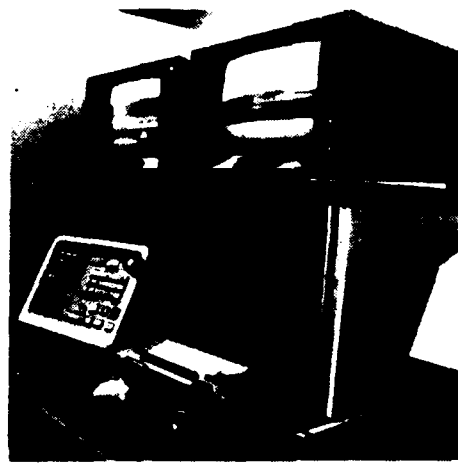
COMBINE THE PROVEN FIRE CONTROL
COMBAT SIMULATOR WITH THE LOW COST
VISUAL SYSTEM TO PROVIDE AN
AFFORDABLE DIRECT FIRE WEAPONS
TRAINER APPLICABLE TO M1, M2/M3,
M60, LAV, SP70, LVT



**Simulated Main Gun, Machine Gun, Missile, Howitzer, Laser
Malfunctions, Ambient and Target Engagement Conditions
Identifiable Targets — Stationary, Moving
Crew Station is Clone of Combat Hardware
Manageable Software
Simplified Maintenance
Identifies Potential Gunners
Trains Gunners and Commanders
Sustains Proficiencies
One Portable Module That Performs in the Field as well as in
the Institution
Affordable, Approximately 1/4 to 1/3 the Cost of Conventional
Computer Image Generation Systems**



**CLONE OF COMBAT CREW
STATION
ACTUAL COMBAT HARDWARE**



**BUILT IN SCORING AND
EVALUATION
EASY TO OPERATE
BUILT IN TEST**



**MANAGEABLE SOFTWARE
EXPANDABLE
MAXIMUM FLEXIBILITY**

KEY FEATURES

- Affordable
- CGI (Low Cost Visual)
- Built-In Test
- Flexibility-User Can Develop Scenarios
- Realism
- Scoring & Record Keeping

MEETS TRAINING OBJECTIVES

- Sustains Gunner Proficiencies
- Trains Gunner/Commander Interactions

TRAINING APPLICATIONS

Expands For Unit Training

- Platoon
- Company
- Force On Force

COMBAT VEHICLE APPLICATIONS

- M1
- M60 Series
- M2/M3

DEMONSTRATION SYSTEM FACTS

- **Visual System Typical Technical Characteristics:**

12 object generator circuit boards (expandable to 21)

Scene complexity - 30 objects typically, 152 objects maximum
(with 12 object generator boards)

Resolution - 0.2 mils at 10 power (limited by low cost displays)

Bandwidth - 12 MHz, Frame rate - 30 Hz, interlace - 2:1

32 step Grey scale, 32,768 theoretical color combinations

- **Computer:**

32 bit mini-computer, 512 kilobytes RAM, 67 Megabyte disc drive

- **Displays:**

13 inch diagonal screen, 640 X 512 pixels (.31mm Tridot pitch)

- **Power:**

120 VAC, 60 Hz, two 30A circuits

GENERAL DYNAMICS
Land Systems Division
P.O. Box 1901
Warren, Michigan 48090 U.S.A.

Direct Fire Weapons Trainers

FOR THE FOLLOWING SERIES OF WEAPONS FAMILIES

M48

M60

M1

M2/M3

LAV

LVT

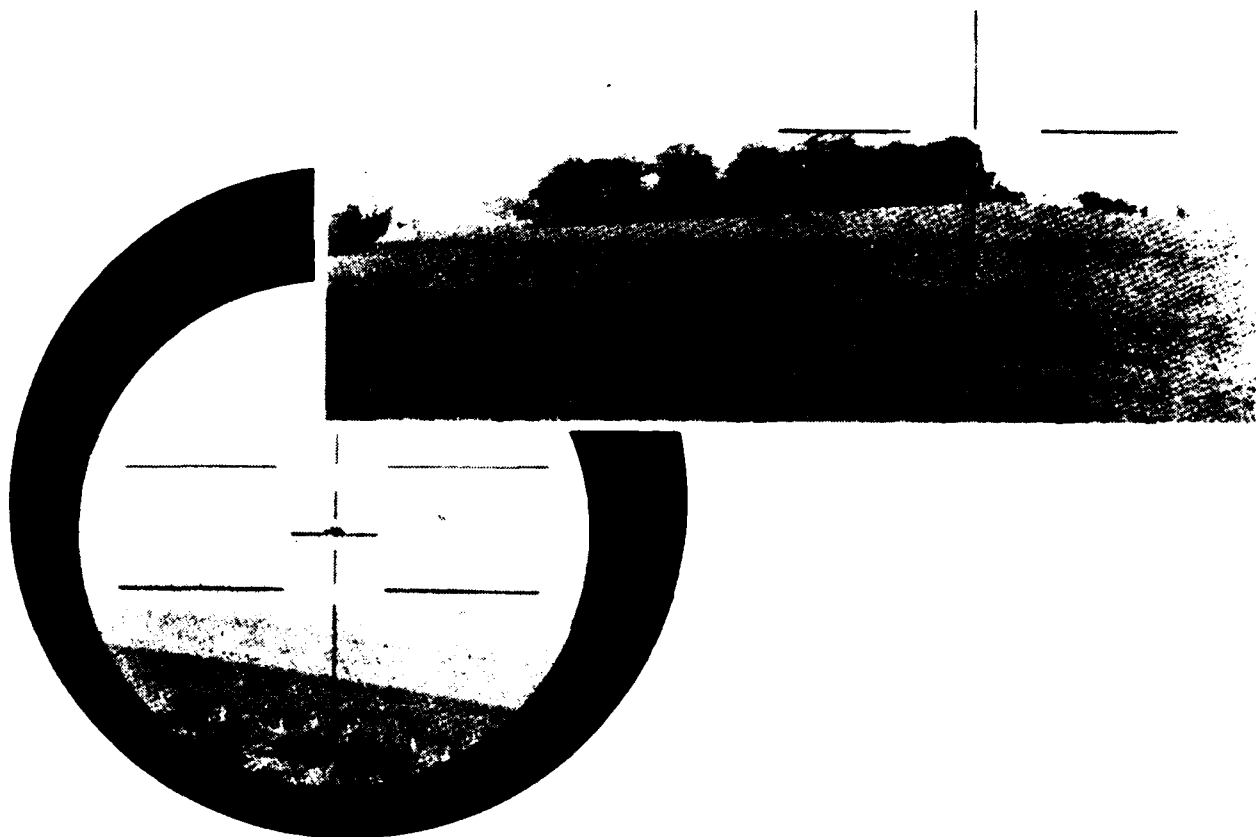
**FOR ADDITIONAL INFORMATION CONTACT:
GENERAL DYNAMICS LAND SYSTEMS DIVISION
P.O. BOX 1901, WARREN, MI 48090
313 497-7129 Telex: 4320121**

CONDUCT OF FIRE TRAINER

With COFT Singer-Link offers cost-effective Tank Gunnery training equipment through . . .

. . . a detailed knowledge of Tank Gunnery procedures and techniques used by armies throughout the world.

. . . utilisation of most advanced technology available in field of Gunnery simulation.

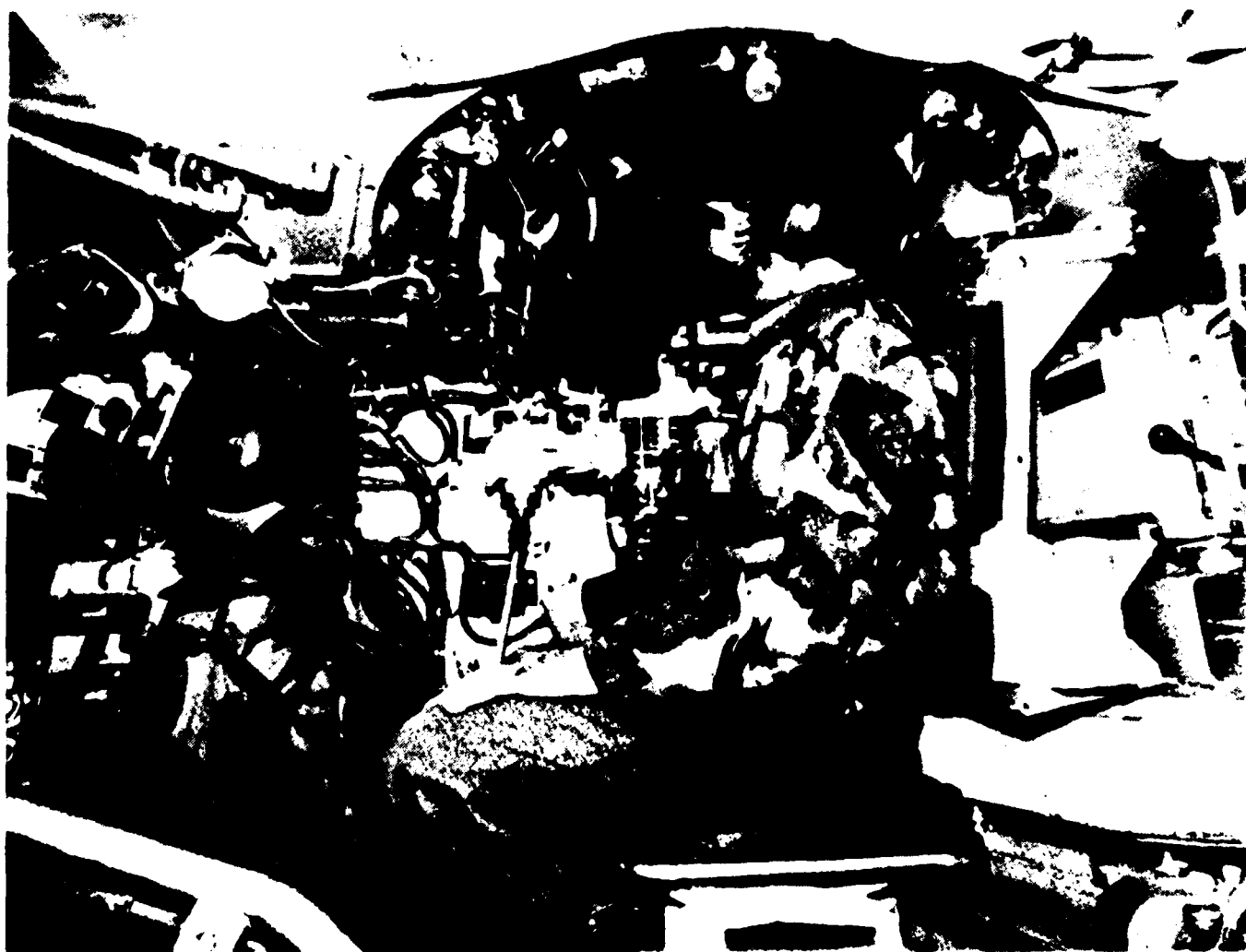
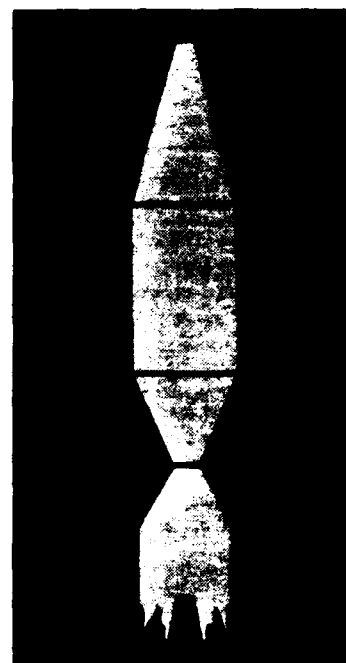


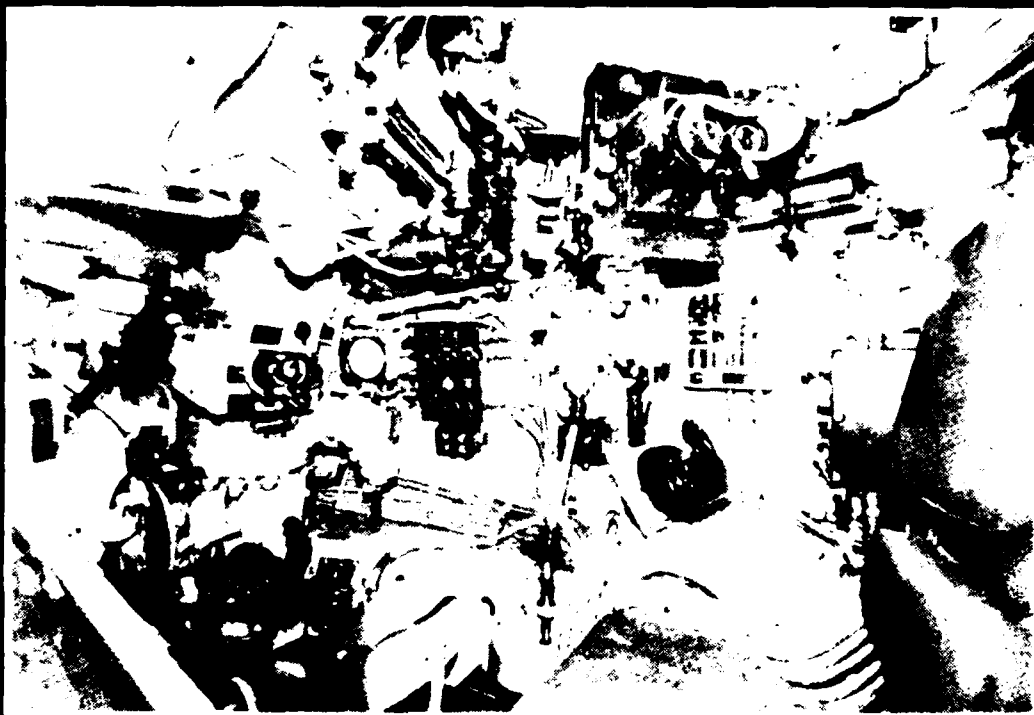
COFT is capable of simulating armoured vehicle weapon systems including day and night optical sights, laser rangefinders and advanced fire control systems. Ballistic representation of large calibre and high velocity rounds as well as more conventional ammunition.



Training Benefits . . .

- ★ Maintains higher skill levels through increased practice.
- ★ Realistic training as an integrated crew for Commander and Gunner.
- ★ Objective assessment of student performance.
- ★ Close interface between instructor and students.
- ★ Easily varied exercises.
- ★ Experience of combat conditions and scenarios.
- ★ Realistic visual representation of terrain, targets and tracer.
- ★ Variable firing conditions.
- ★ Training with all types of ammunition.
- ★ Experience of malfunctions in complete safety.





Scope of Training . . .

COFT provides training for Commander and Gunner as an integrated team in . . .

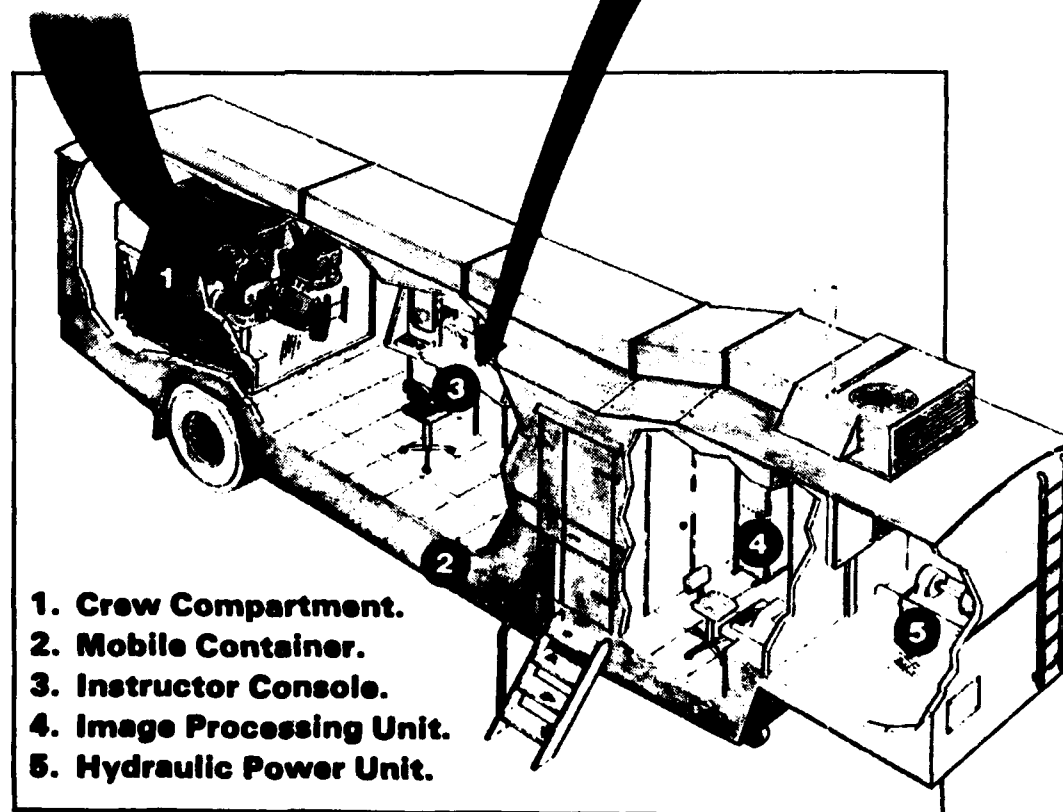
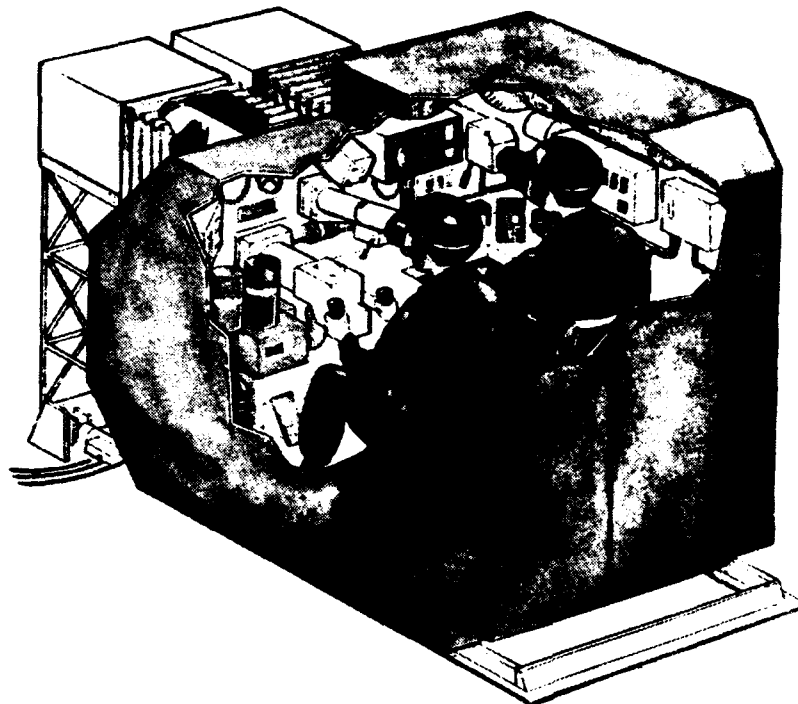
- target detection and identification
- allocation of target priority
- initial estimation of target range
- selection of most effective ammunition
- gun laying
- initial firing and assessment of fall of shot
- corrections to aim

ALL TASKS AIMED AT INCREASING PROBABILITY OF FIRST TIME
HIT

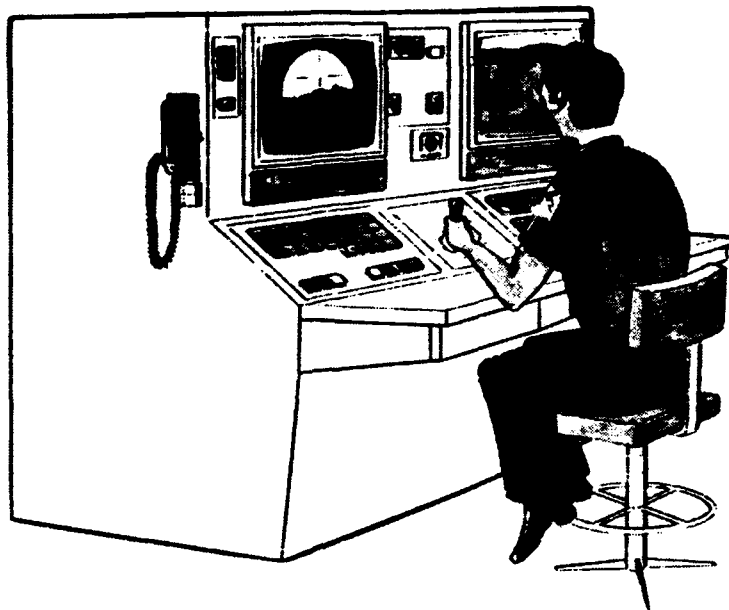
The crew training environment is an internal facsimile of the actual tank turret. To provide realistic training the simulated turret provides:

- ★ Realistic representation of Commander's and Gunner's equipment and sights.
- ★ Sound simulation.
- ★ Turret recoil.

COFT...



1. Crew Compartment.
2. Mobile Container.
3. Instructor Console.
4. Image Processing Unit.
5. Hydraulic Power Unit.



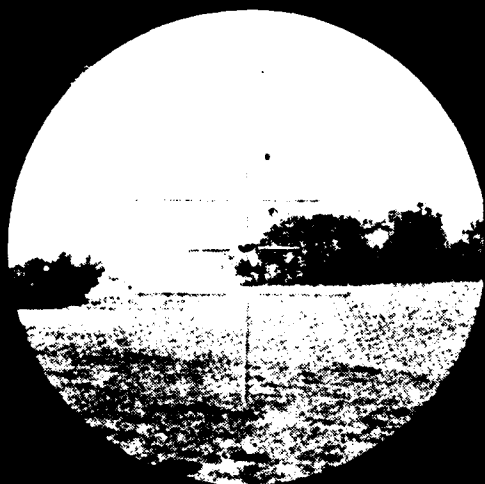
Simple to operate, the instructor's console is designed for maximum concentration on student's performance.

Facilities include:

- ★ Repeat views through sights of trainees.
- ★ Flexible exercise programming.
- ★ Demonstration facilities and controls.
- ★ Freeze and playback functions.
- ★ Simulated malfunctions inputs.
- ★ Exercise timing and scoring.
- ★ Full intercom system.
- ★ Variable environmental conditions.

In training exercises requiring full crew cooperation the instructor is provided with facilities to act as loader.

Visual Features...

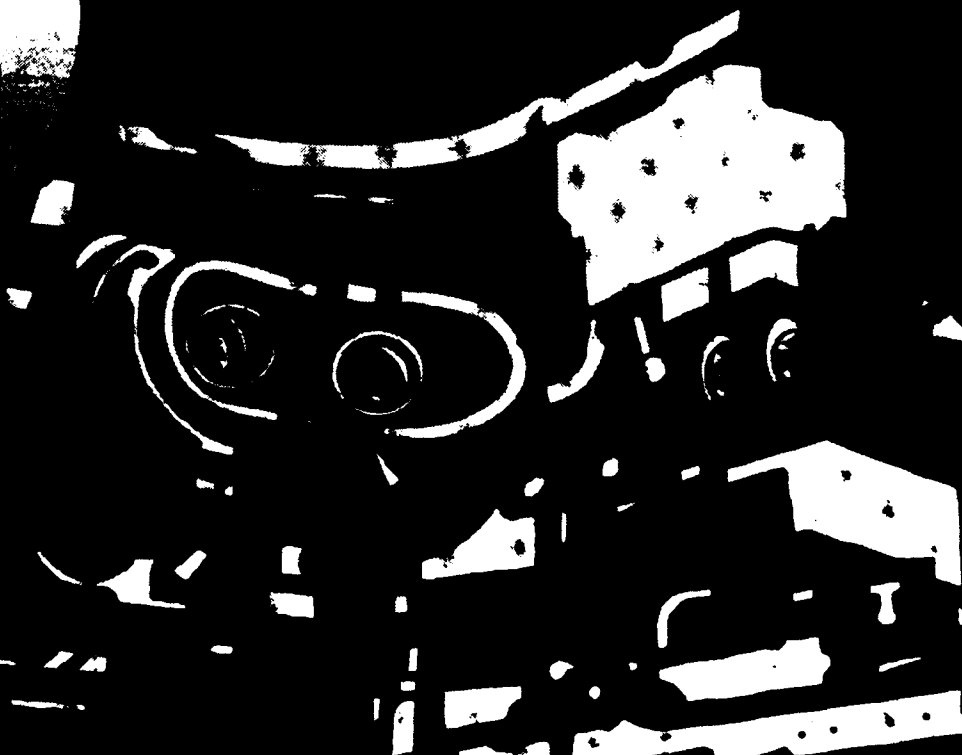


Full colour
terrain
with occulted
target and
tracer

Full colour visual scenes, essential for maximum training value, are injected into sights using computer generated imagery techniques specifically adapted to Gunnery simulation. This visual system, already proven by a prototype simulator, takes full account of customer-orientated criteria of cost, reliability and flexibility.

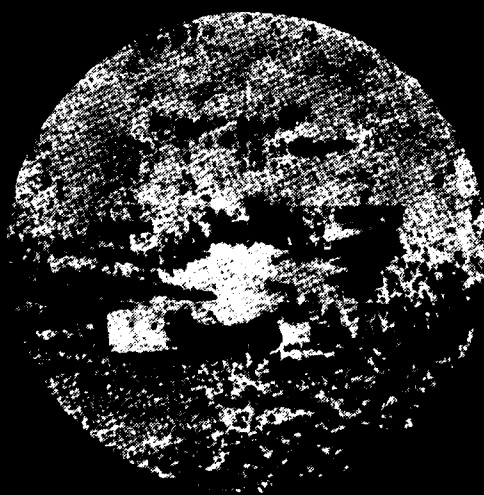


Hit effect

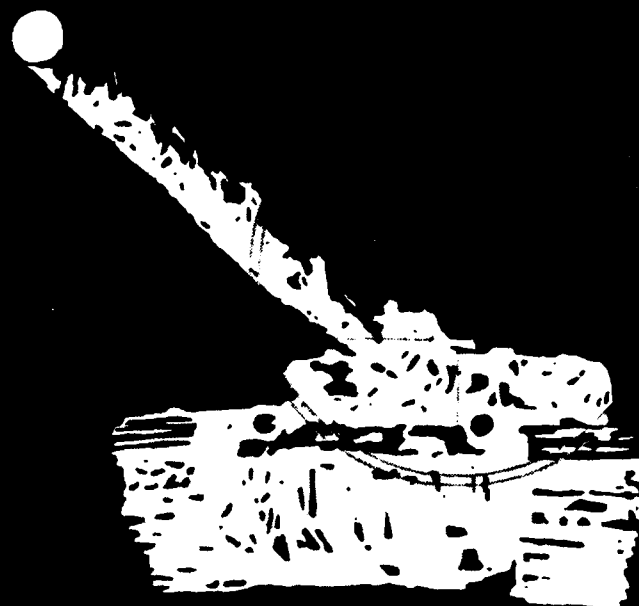




Low visibility



Infra red



Employing unique image processing techniques the COFT visual system provides following main features

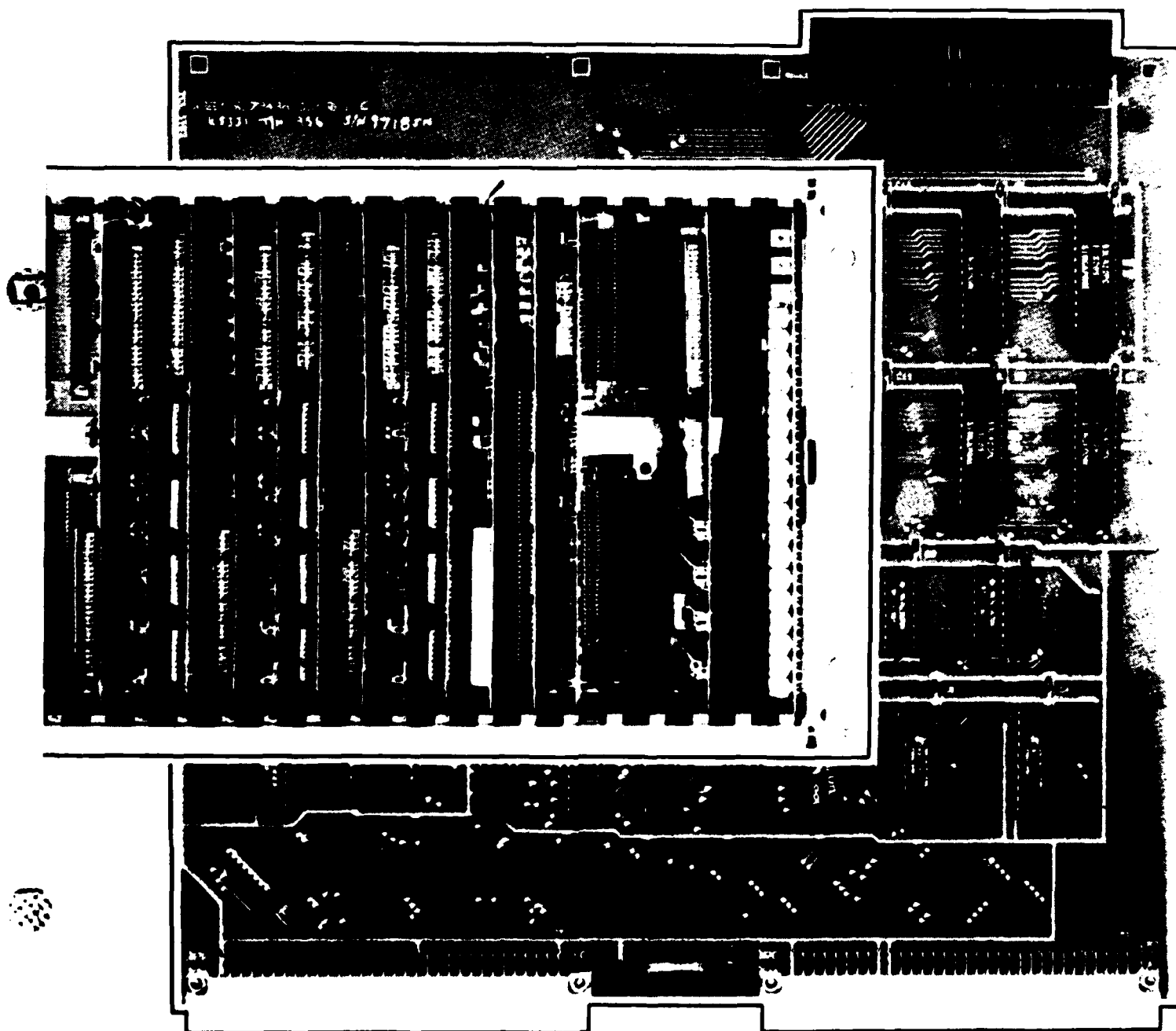
- ★ True to life background scenes of terrain
- ★ Simultaneous targets -- stationary or moving variable directions
- ★ Easily programmable scenarios with various types of targets.
- ★ Target size accurately related to range. Variable aspect images
- ★ Realistic tracer effects
- ★ Muzzle flash and smoke burst on target and miss effects appropriate to target and ammunition
- ★ Variable visibility and night firing. Night illumination effects
- ★ Occulting of targets by obstacles
- ★ Multiple data channels for multiple sights

Computing System . . .

Singer-Link have pioneered the use of microprocessors in aircraft simulation systems already in use by military customers. In Gunnery simulation the company has taken full advantage of the rapid evolution of micro-electronic components and image processing techniques. Consequently COFT offers the following technological advantages.

- ★ Latest high speed microprocessors avoid the need for expensive central computers and associated maintenance.
- ★ Microprocessors provide expansion capability, reliability, accuracy and flexibility.
- ★ Built-in test equipment and test routines allow easy maintenance with reduced test and repair times.

High availability is achieved through increased reliability at minimal cost.



Support . . .

Fully integrated support package tailored to suit customers maintenance philosophy:

- ★ Comprehensive documentation package designed to facilitate operation, maintenance and general support of the total system.
- ★ Comprehensive initial training for customers technicians and engineers with follow-on training packages to maintain expertise levels over the life of the simulator.
- ★ Fully qualified field engineers for either residential support or on call assistance.
- ★ Provision of initial spare part packs selected to meet customers specific maintenance philosophy together with all tools and test equipment required to support the maintenance effort.
- ★ In service product services providing:

CENTRAL COMMUNICATION POINT
TECHNICAL ASSISTANCE
EMERGENCY SUPPORT SERVICE
REPAIR SERVICE
SPARES REPLENISHMENT SERVICE
WARRANTY SERVICE
CATASTROPHIC SPARES SERVICE
UPDATES/MODIFICATION SERVICE
SIMULATOR RELOCATION

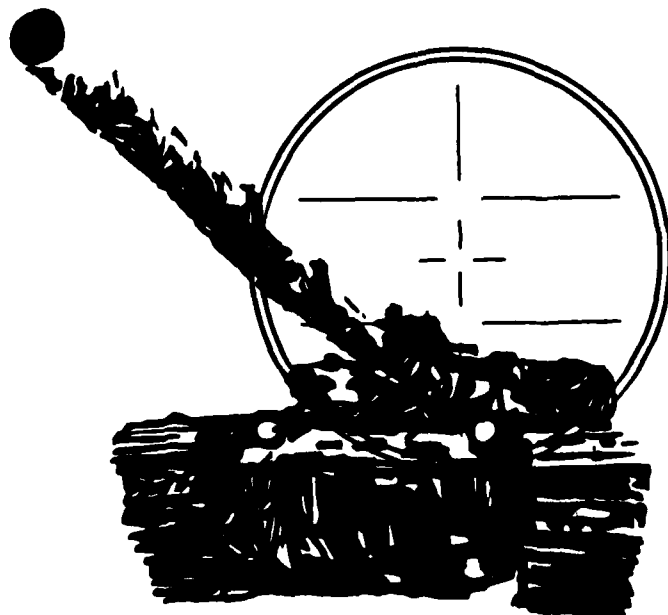
For Further Information

Contact:

**THE SINGER COMPANY (UK) LTD.,
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Churchill Industrial Estate,
Lancing,
Sussex
BN15 8UE**

Telephone: Lancing (0903) 755881

Telex: 87165 LINKSI G



PROCEDURES TRAINER

GIRAVIONS DORAND
industries

EVIC
DX 201

APPAREIL D'AIDE A L'INSTRUCTION

TRAINING AID



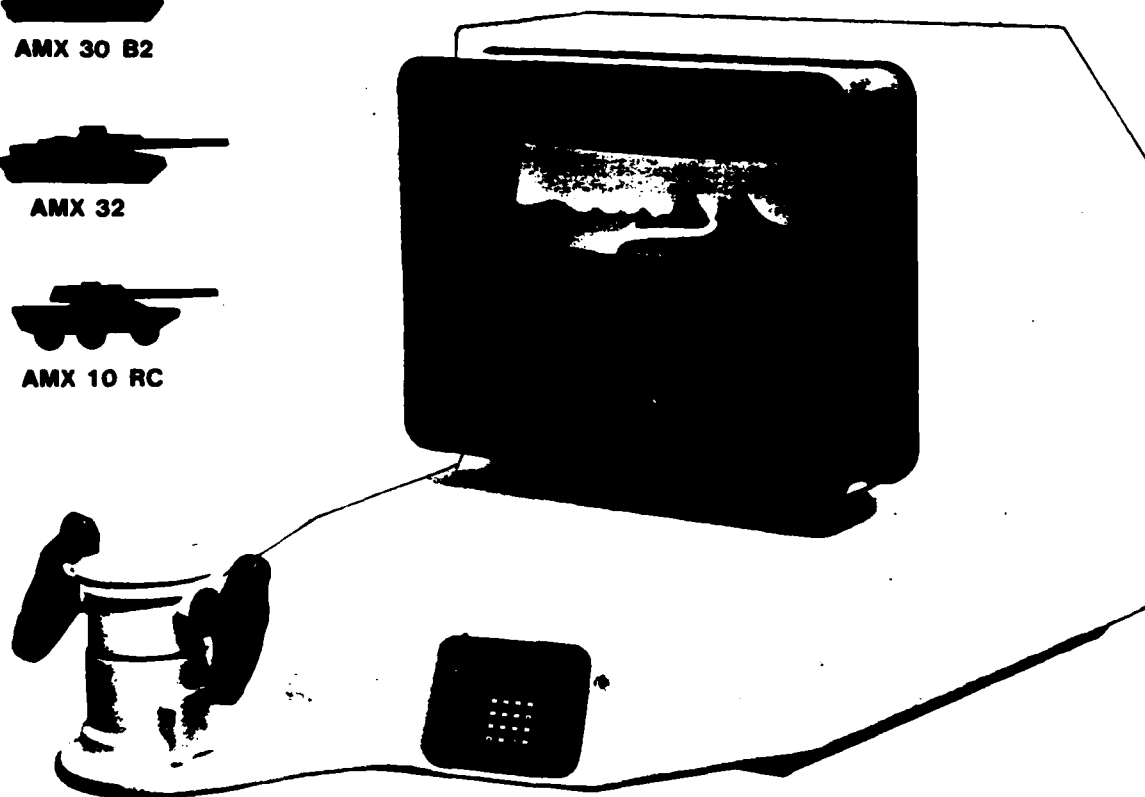
AMX 30 B2



AMX 32



AMX 10 RC



POUR CONDUITE DE TIR AUTOMATIQUE
FOR AUTOMATIC FIRE CONTROL SYSTEM

COTAC

L'appareil d'instruction DX 201/EVIC est destiné à former et entraîner les tireurs de chars et véhicules blindés au maniement de la conduite de tir automatique COTAC. De conception et de mise en œuvre très simples, cet appareil permet d'acquérir et d'entretenir la dextérité manuelle des tireurs pour l'exécution d'une séquence de tir rapide et précise, sans faire appel à l'installation de tir réelle.

The DX 201/EVIC training aid equipment is intended for training gunners of battle tanks and armoured vehicles fitted with a COTAC automatic fire control system in the execution of firing sequences. Very simple in design and operation, it provides basic training in the handling of the system controls, without operating the real fire control installation.

Associated with the automatic fire control system

GIAT

DX 201

COMPOSITION

L'appareil DX201 comprend essentiellement :

- un système de visualisation (écran TV)
- un palonnier tireur
- un pupitre de commande permettant de choisir les différents modes de fonctionnement
- un ensemble électronique intégré dans l'appareil.

UTILISATION

L'écran vidéo du moniteur TV fait apparaître :

- un paysage stylisé dont une partie s'inscrit dans un cercle mobile représentant le champ de la lunette de visée
- une cible fictive, du type OTAN, fixe ou mobile dans le paysage
- le réticule de la conduite de tir.



L'appareil sanctionne les opérations du tireur en faisant apparaître sur l'écran divers messages signalant les erreurs commises. Il indique également le temps total de la séquence et le cumul des tirs réussis.

COMPOSITION

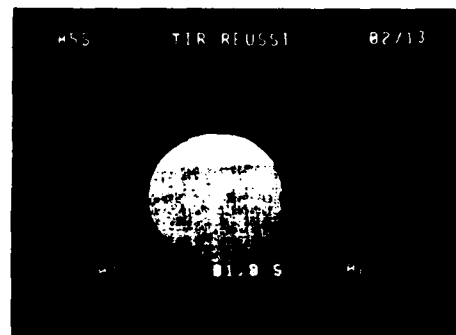
The DX 201 consists essentially of :

- a display system (TV monitor)
- a gunner's swing bar
- a control unit allowing to select different operating modes of the simulator
- a processing electronics unit integrated in the equipment.

UTILIZATION

The video display on the TV monitor indicates to the trainee :

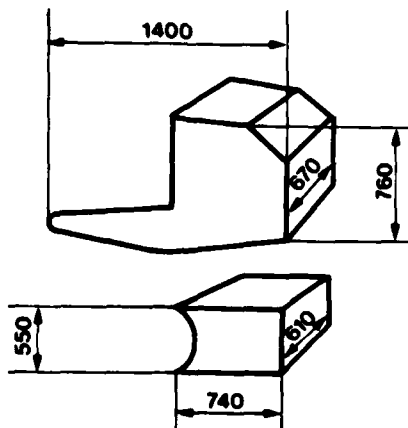
- a stylized landscape in the field of view of his aiming sight, indicated by a luminous circle
- a fixed or moving NATO type fictive target
- the fire control system reticle.



Gunner's actions are automatically scored and his aiming errors are displayed on the TV screen. The total time of the firing sequence and the number of successful firings are also indicated.

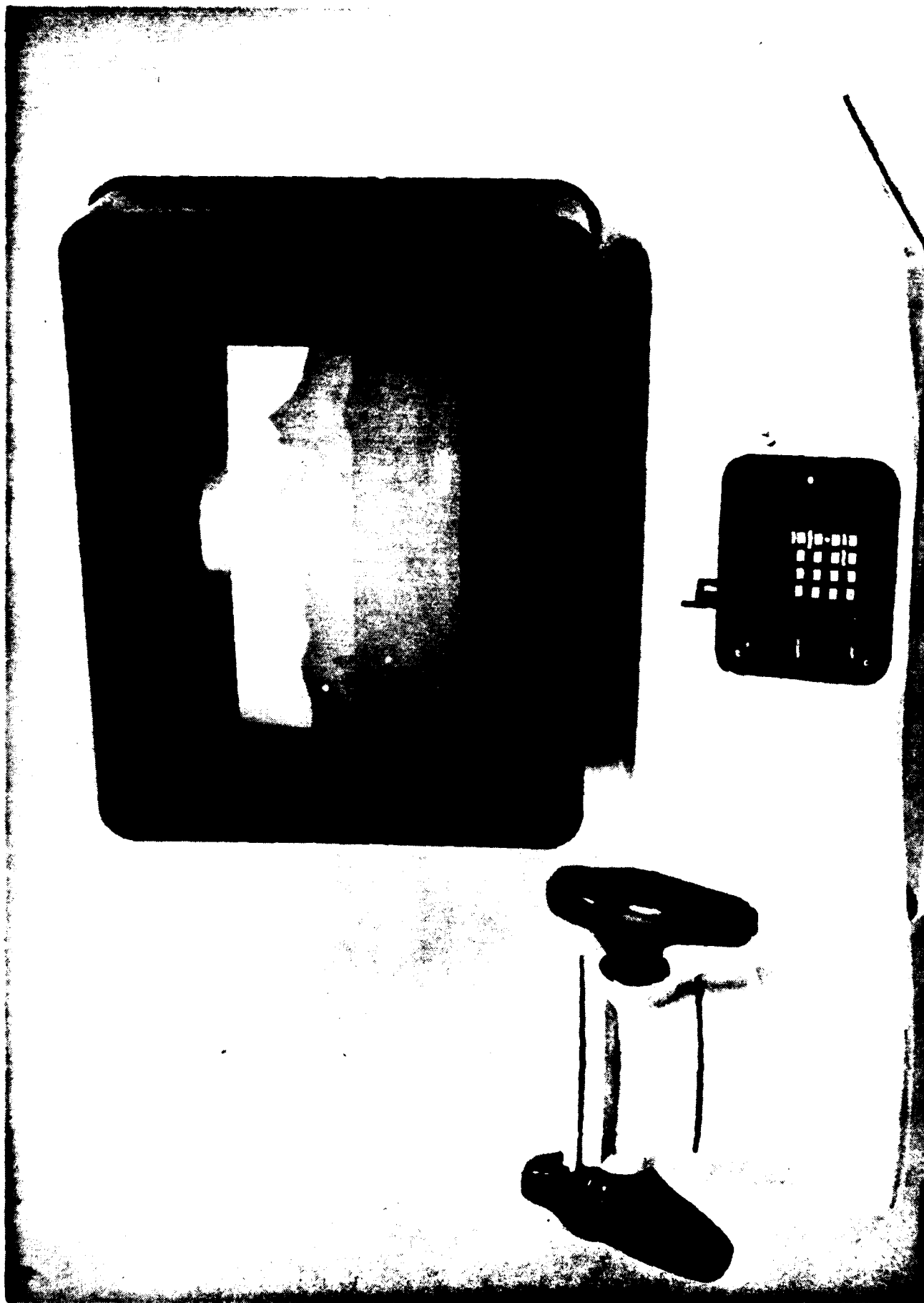
CARACTERISTIQUES

- Alimentation : 220 V~
- Ecran TV : 51 cm
- Sortie magnétoscope optionnelle
- Utilisation en salle
 - sur table
 - avec support démontable
- Température de fonctionnement : 0°C à + 40°C



CHARACTERISTICS

- Power supply : 220 V AC
- TV screen : 51 cm
- A video recorder (optional) may be connected to the equipment
- Utilization in classroom
 - on table
 - with removable support
- Operating temperature range : 0°C to + 40°C



GIRAVIONS DORAND DX 201

MK-60 TANK GUNNERY TRAINER™



PERCEPTRONICS

MK-60 TANK GUNNERY TRAINER

Perceptronics' MK-60 Tank Gunnery Trainer is designed to provide soldiers with realistic and effective engagement skills training in both initial entry and sustainment training modes. The device, developed under the sponsorship of the Defense Advanced Research Projects Agency and the U.S. Army Training Support Center, combines advanced video disc and microcomputer technologies and is comprised largely of off-the-shelf components. It is a real-time, interactive, part-task training system which is capable of presenting a wide range of engagement scenarios to the gunner, along with accurate visual, audible, and tactile cues normal to each engagement exercise, from the initial fire command to "cease fire."

Through controls and displays located on the front of the system, the gunner can train independently with the device, or an instructor can select exercises for the gunner, thereby tailoring the training to individual soldier needs. The device scores the gunner's performance based on parameters established for each exercise and a series of algorithms. The gunner's score and performance data (e.g., the position of each round fired with respect to the target, the amount of time used to fire each round, etc.), along with an indication of skills (such as tracking) which need improvement are displayed for critique purposes.

The basic design concept can be adapted to the gunnery requirements of any tank configuration. It can also be used in numerous other applications involving weapon aiming and firing (e.g., IFV/CFV, TOW), vehicular control (e.g., tank, aircraft, ship), and procedures and tactics (e.g., maintenance, decision making).

VIDEO DISC PLUS MICROCOMPUTER

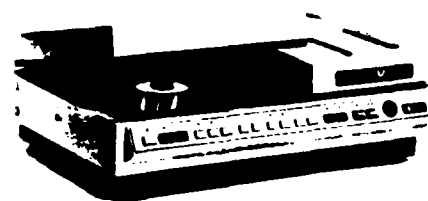
An interactive simulation system, whether it be for gunnery training or flight simulation, requires the capacity to store vast amounts of data and the ability to retrieve, manipulate, generate, and display data rapidly. In designing the MK-60, Perceptronics has taken advantage of emerging video disc and microcomputer technology to acquire these capabilities while avoiding the size,

cost, and complexity disadvantages characteristic of earlier simulation systems.

Video disc technology provides the means to store large amounts (54,000 frames per disc) of video information in compact form, thereby reducing the computer storage capacity normally required by computer-generated imagery approaches to simulation. Each frame or sequence of video data is accurately located on the disc and can be randomly accessed almost instantaneously, based on programmed instructions from the microcomputer.

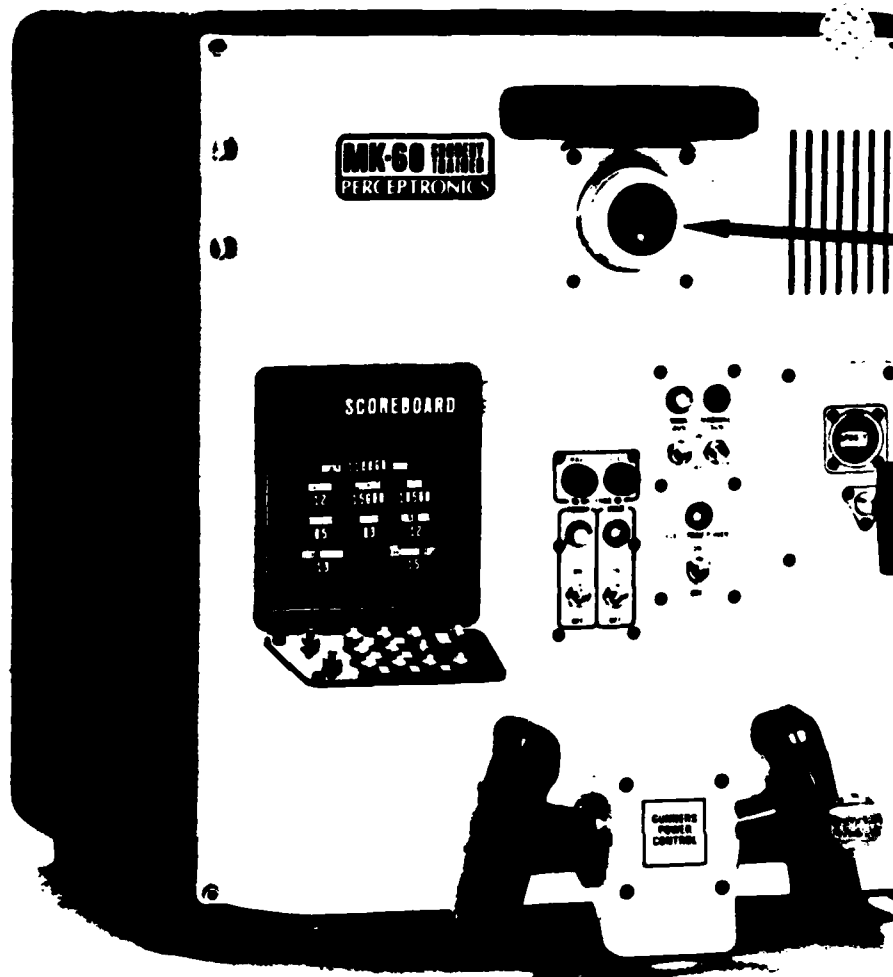
The video disc itself is quite durable. It is handled much the same as an ordinary phonograph record and since the information on the disc is sensed by a laser, it is not subject to wear through usage. The realistic video scenes, displayed to the gunner in color, are produced by filming actual target vehicles

operating over a variety of terrain settings, light levels, and obscuration conditions. The video disc player used with the MK-60



is desk-top size, commercially available, simple to operate, and requires no modification for use in the trainer.

The microcomputer is the heart and brains of the system. It accesses the target scenes for the exercise selected, keys the synthetic sound effects required, senses and processes operator actions,



Firing Vehicle Movement

Simulated movement of the firing vehicle provides realism for training to shoot on the move.



Gunner Controls

The trainer can be fitted with gunner controls for any weapon system. Thus, the gunner can follow the same sequence of actions that is used in employing a particular weapon system.



Scoring and Critique

Gunner performance is automatically scored and displayed by the computer for critique purposes.

- Moving Targets
- Natural Environments
- Full Color
- Other EM Bands (IR & MMW)
- Firing Obscuration
- Miss Burst
- Hit Blast
- Moving Platform

Reticle Projection

The projected reticle duplicates the reticle of the combat weapon system so that the gunner employs the same sight picture that would be used on the actual system.

Target Effects

Computer generated tracer and hit indication accurately displayed allows realistic sensing and fire adjustment.

Firing Blast & Obscuration

Computer generated firing effects add realism.

Sound Effects

Appropriate computer-generated sounds transmitted through the gunner's headset simulate the internal and external sounds which commonly accompany target engagement actions, as well as the gunner/commander interface.

generates visual effects in the target scene, keeps time data, scores, and displays performance data.

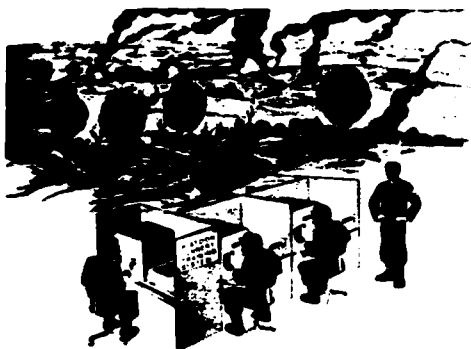
OUTSTANDING PERFORMANCE TRAINING FEATURES

Target Scenes

Filmed target scenes of any degree of challenge can be presented. Simple stationary or moving vehicles can be used for initial training. As skills develop, gunners can be challenged with evasive targets, multiple targets, battlefield clutter, smoke, etc. Films taken through night sights can simulate near IR or thermal imaging.

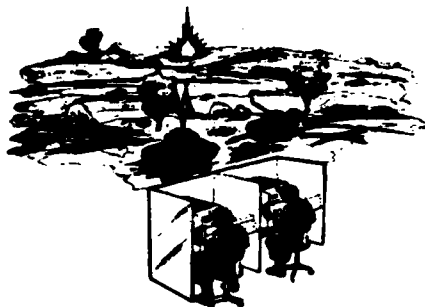
TEAM TRAINING NETWORKS

The MK-60 is a single station trainer. However, a multiple station configuration is now being created to provide collective task skills training by adding additional simulator units and reprogramming the engagement scenarios to interface additional participants. Through such networking, effective gunner/commander team training (especially important in minimizing the effects of personnel turbulence) can be provided.



By combining five units, gunners can practice engagement and fire control as encountered in tank platoon operations, with the roles of tank commanders and platoon leader simulated by the devices. By adding additional units, tank platoon training involving all gunners and commanders can be conducted. Networking of Perceptronics' trainers, therefore, provides a unique opportunity

to practice distribution of fire and the unit fire and movement techniques of combat not heretofore possible without extensive investment in range facilities, ammunition, and equipment.

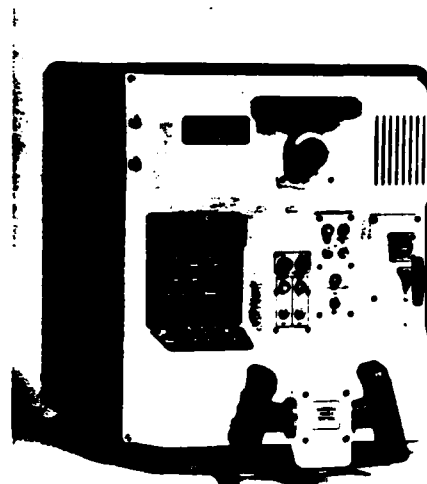


An arcade-touch can be achieved through device configurations which play gunner against gunner. A competitive "Shootoff" configuration, with side-by-side trainers, in which the winner is the gunner who scores highest on a succession of common target problems, is one example.



Another example, a competitive "Quick-Draw" configuration, would determine

the winner on the basis of one-on-one engagement scores. Such gaming techniques not only provide motivation, which increases the soldiers' desire to practice, but introduces a degree of pressure in achieving rapid, accurate engagements.



For further information on the Perceptronics MK-60 Tank Gunnery Trainer, call or write:

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PERCEPTRONICS

Perceptronics, Inc.
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**Sanders
Combat Classroom[®]
is the
Image of Reality**

Sanders Brings Realism to the Classroom Cost Effectively...



Sanders technology, the foundation of video games, has led to an improved approach to training. We have built upon our many video game and graphics patents and our training support expertise to develop a modular, interactive training program: The Combat Classroom.SM

Here's why our Combat Classroom is ideal for many training applications:

Challenging and Motivational Training Methods

Interactive video graphics hold student interest through active participation. Students get feedback instantly and continuously, encouraging them to improve their skills. And because video is so popular, today's students are particularly receptive to interactive video training.

Backed by Sanders Training Specialists

Sanders offers not only a reliable hardware/software package, but also intensive training support customized to individual requirements. Once our training professionals help you define your objectives, they design the training programs to meet those goals.

After our trainers complete task analysis and develop scenario lesson plans, they evaluate the program for effectiveness. The video portion of the training program is reinforced with easy-to-understand manuals.

Provides Cost-Effective Training

The Combat Classroom provides graphic realism through video simulation at a fraction of the cost of actual operations. The equivalent of hands-on training is delivered at an affordable price.

Easy to Use

The portable Combat Classroom is easy to install, simple to operate and highly reliable. For weapons training, the student just aims a modified weapon and fires at the video target. For procedures and maintenance training, the student is presented with either a graphic or video image of the equipment and interacts with a self-paced lesson through a touch screen, joystick, light pen or keyboard. In all cases, skill proficiency is measured automatically.

Built-in Flexibility

Designed to meet multipurpose training requirements, the modular Combat Classroom can be programmed to display realistic training scenarios in:

- multiple target engagement and weapon utilization
- unit level tactics development (war gaming)
- procedures and maintenance training
- C³ network management
- ASW tactics

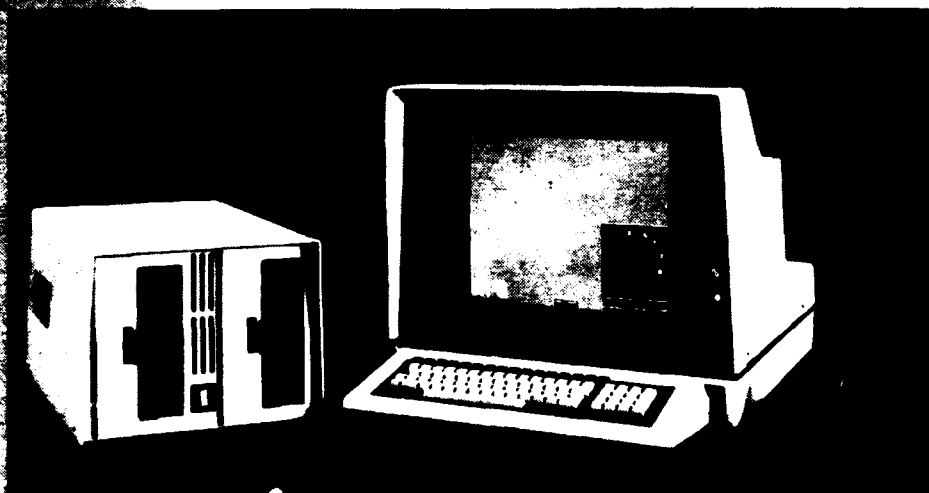
The Combat Classroom is easy to use and can be configured to meet most training needs. This broad product capability is achieved through the use of Sanders' patented, multi-media, microcomputer-based training system. It is simple and user-friendly, higher order computer graphics, and a variety of input devices. Challenging and Motivational Training Methods place Integrated Logistics Support (ILS) in the classroom. Easy to use, flexible, and cost-effective, the Combat Classroom offers what you need to make your training program.

It's All Based on Proven Experience: Developing Total Training Systems

Sanders has unique experience in the development and support of integrated training systems. Our equipment for military training has a solid reputation for performance and reliability.

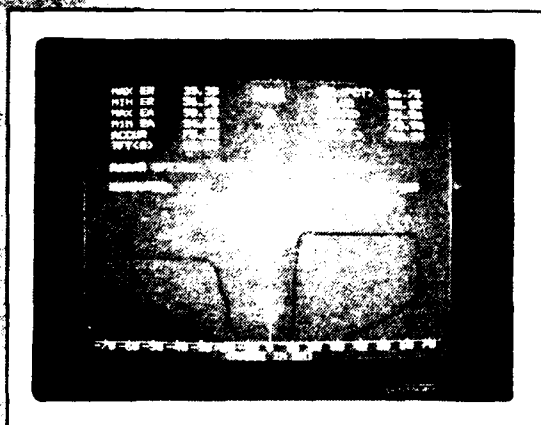
- Operator Training: F-15, F-16, F-18, F-19, F-20, F-21, F-22, F-23, F-24, F-25, F-26, F-27, F-28, F-29, F-30, F-31, F-32, F-33, F-34, F-35, F-36, F-37, F-38, F-39, F-40, F-41, F-42, F-43, F-44, F-45, F-46, F-47, F-48, F-49, F-50, F-51, F-52, F-53, F-54, F-55, F-56, F-57, F-58, F-59, F-60, F-61, F-62, F-63, F-64, F-65, F-66, F-67, F-68, F-69, F-70, F-71, F-72, F-73, F-74, F-75, F-76, F-77, F-78, F-79, F-80, F-81, F-82, F-83, F-84, F-85, F-86, F-87, F-88, F-89, F-90, F-91, F-92, F-93, F-94, F-95, F-96, F-97, F-98, F-99, F-100, F-101, F-102, F-103, F-104, F-105, F-106, F-107, F-108, F-109, F-110, F-111, F-112, F-113, F-114, F-115, F-116, F-117, F-118, F-119, F-120, F-121, F-122, F-123, F-124, F-125, F-126, F-127, F-128, F-129, F-130, F-131, F-132, F-133, F-134, F-135, F-136, F-137, F-138, F-139, F-140, F-141, F-142, F-143, F-144, F-145, F-146, F-147, F-148, F-149, F-150, F-151, F-152, F-153, F-154, F-155, F-156, F-157, F-158, F-159, F-160, F-161, F-162, F-163, F-164, F-165, F-166, F-167, 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Combat Classroom hardware/software
packages include:



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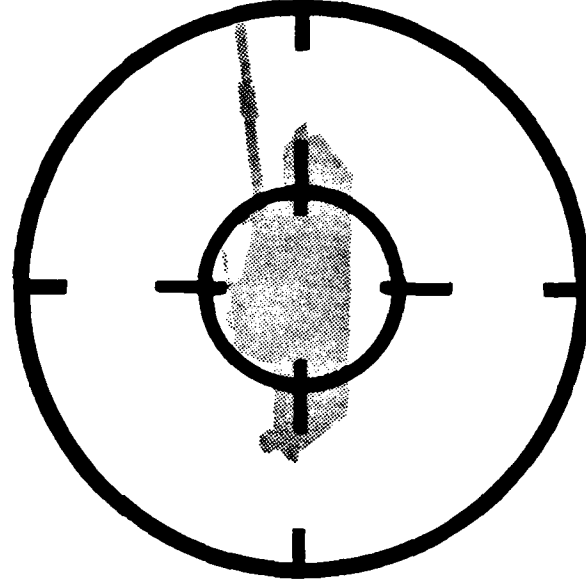


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Anti-Armor
Weapon Trainer*

*includes 25 mm cannon and M-60 machine gun trainer

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1. GENERAL

1.1 Introduction

Fuel shortages, high ammunition costs, complicated logistics, and operational limitations all require the increased use of trainers. Studies on training indicate that for most required levels, trainees learn best under controlled, task-oriented, individual training programs.

TANGA is a low-cost, task-oriented, proficiency enhancement trainer for tank gunners.

Computer-based, compact and portable, it authentically presents battle-field views through a gunsight, and realistically simulates the behavior of targets and turret.

TANGA was designed according to Israel Armor Corps specifications, and is currently in production.

1.2 Trainer Objectives

Improving Gunner Skills

Modern armor warfare demands quick responses from the gunner while firing at longer ranges. The TANGA is designed to improve the gunner's skills in:

- Target location
- Aiming accuracy
- Rapid firing
- Burst-On-Target and Standard Fire correction techniques

TANGA -- CLASSROOM TANK-GUNNERY TRAINER

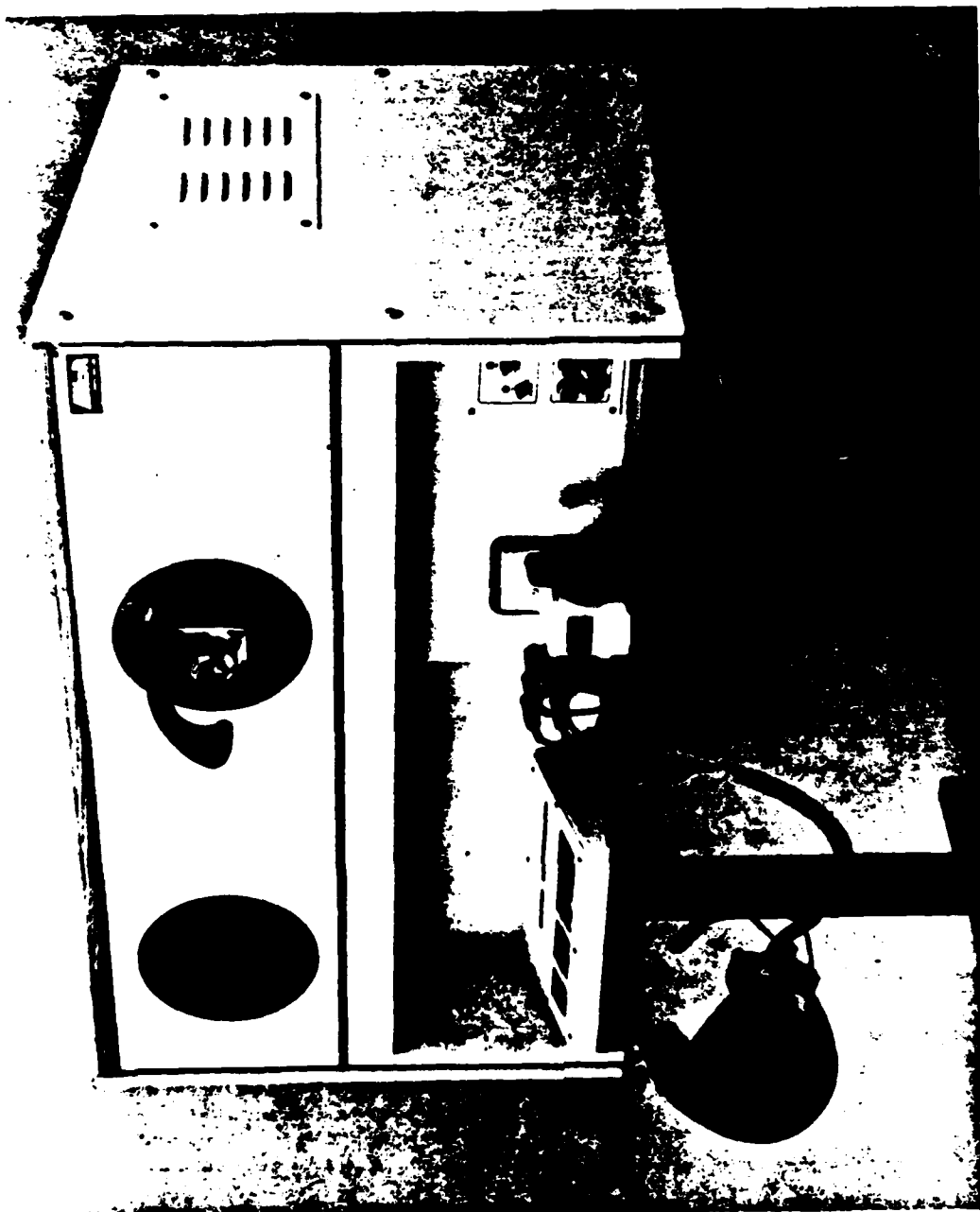


Figure 1 The TANGA System

TANGA - CLASSROOM TANK-GUNNERY TRAINER

Training According to Gunner's Level and Experience

Exercises are varied in kind and complexity. Changing external factors, such as pre-set errors, enables the gunner to proceed through the training at his own pace.

Training Subjects

TANGA efficiently trains the gunner according to his level of knowledge, starting from the basic skills.

The following subjects are covered:

- Use of gunner peritcope
- Aiming procedures
- Standard Fire correction techniques
- Point-of-hit recognition
- Firing rounds in series, including rapid repetition (multiple targets)
- Firing at moving targets
- Tank commander's corrections
- Gunner's corrections

2. DESCRIPTION OF TANGA

2.1 System Definition

TANGA is a low-cost classroom trainer. The system has simple controls, and is easily operated without special instructor staff. Its low cost makes it possible to include TANGA in the equipment of units of battalion size.

TANGA hardware, software, and training exercises were defined and developed by the Training Command of the Israel Defense Forces. Elbit has developed the system further, and it is now utilized routinely in the IDF Armor Corps. Supported by a thoroughly researched system of graduated exercises, TANGA has proven effective in developing gunner proficiency.

The trainer displays the results of each exercise numerically. The trainee observes his performance objectively and immediately and thus learns from mistakes. This training technique works better and faster than any other, including the firing of live ammunition. All these factors make for a highly cost-effective solution to this training problem.

The entire trainer is built into a single cabinet, including the positions of trainee and instructor, projection equipment, computer, and control/display panel.

The trainee sits as he would in the tank, facing a standard gunsight, gun-laying controls, and firing lever. Through the gunsight, he sees a standard reticle and a projected scene representing the combat arena. The same scene is projected on the screen of the instructor, who sits next to the trainee.

The computer calculates and displays the gunner's acquisition time, firing time, and aiming corrections.

2.2

Principles of Operation

All functional units of TANGA are controlled from a central electronic control unit, which is based on a microcomputer (see figure 2). The optical subsystem projects a battle scene in the gunsight and the instructor's display. The position of the projected scene is controllable in order to simulate movement of the turret.

TANGA simulates the optical effects of flash, gun jump, bright spot (indicating hit point), and the temporary loss of vision caused by smoke at the moment of firing. Further realism is provided by audible simulation of gun firing.

The gunner's station is equipped with a gunsight control unit, switches, and pushbuttons for selecting main gun, machine gun, and six ammunition types.

The instructor's station is equipped with display and control units. These allow him to select one of nine exercises and to monitor its progress and the gunner's performance. The exercise is selected by a simple dialogue with the system in which the instructor need only give 'yes' or 'no' responses. The standard exercises provided with the system range from simple gunlaying exercises to attacks on moving targets.

The instructor's control and display equipment is used to control deviations, and to display the gunner's aiming corrections and response times. The instructor chooses the exercise and its level of difficulty.

Reliability and maintainability of the system are assured by a sequence of built-in tests, which are activated by the instructor, who receives the results on his display.

TANGA -- CLASSROOM TANK-GUNNERY TRAINER

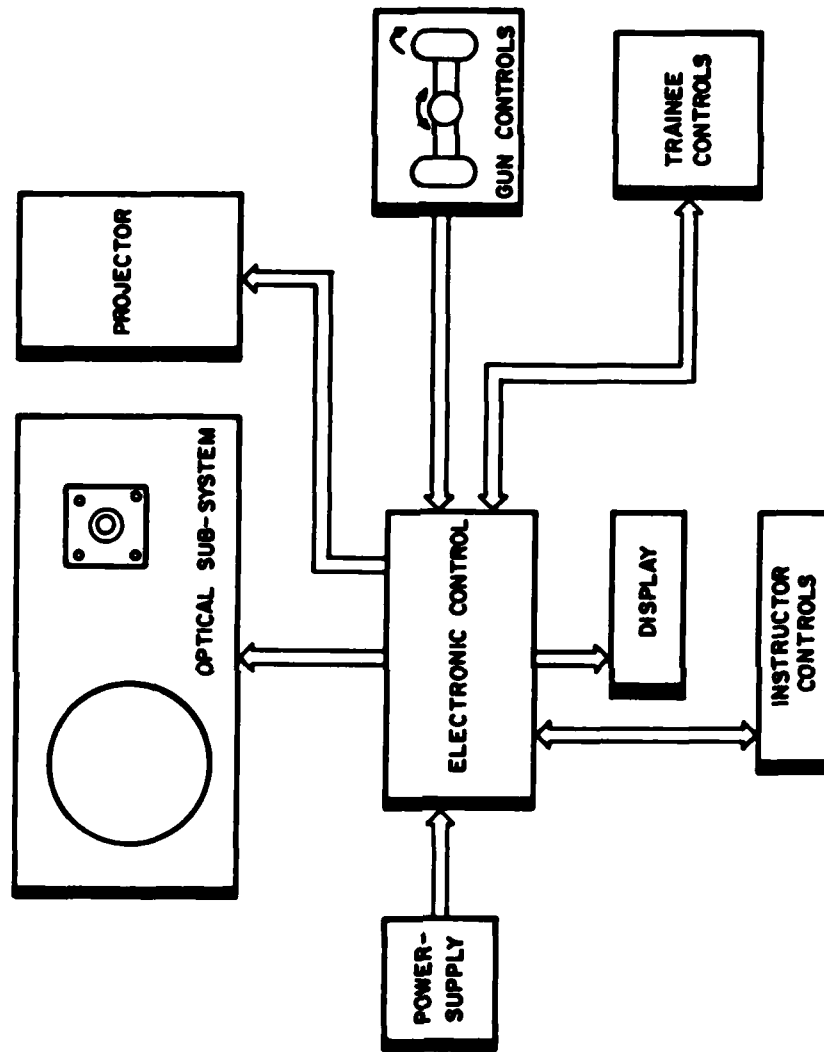


Figure 2 Block Diagram of TANGA

3. SYSTEM FEATURES

3.1 Highlights

- Cost-effective, task-oriented tank gunnery training
- Improves gunner skills and performance
- Advanced training concept
- Real controls, display, and effects
- Built-in Test

3.2 Personnel Training

Many gunners may be trained since:

- TANGA's low cost allows many trainers to be procured despite limited budgets
- TANGA's small size and light weight ensure its availability even at the remotest locations
- TANGA's reliability and simple operation ensure its continuous use
- TANGA's entertaining character and authentic scene and targets encourage the trainee to continue training on his own.

3.3

Conservation of Resources

TANGA permits unlimited firing without consuming fuel or ammunition, items in increasingly short supply.

3.4

Supervision and Evaluation

The trainee is continuously supervised, aided, and evaluated by the instructor. This gives effective crew screening as well as training.

3.5

Simple Operation

The instructor starts the operation by defining a new exercise. The trainer is then ready for operation.

4. OPTIONS

The following options are available, and may be added to the basic system as required by the customer:

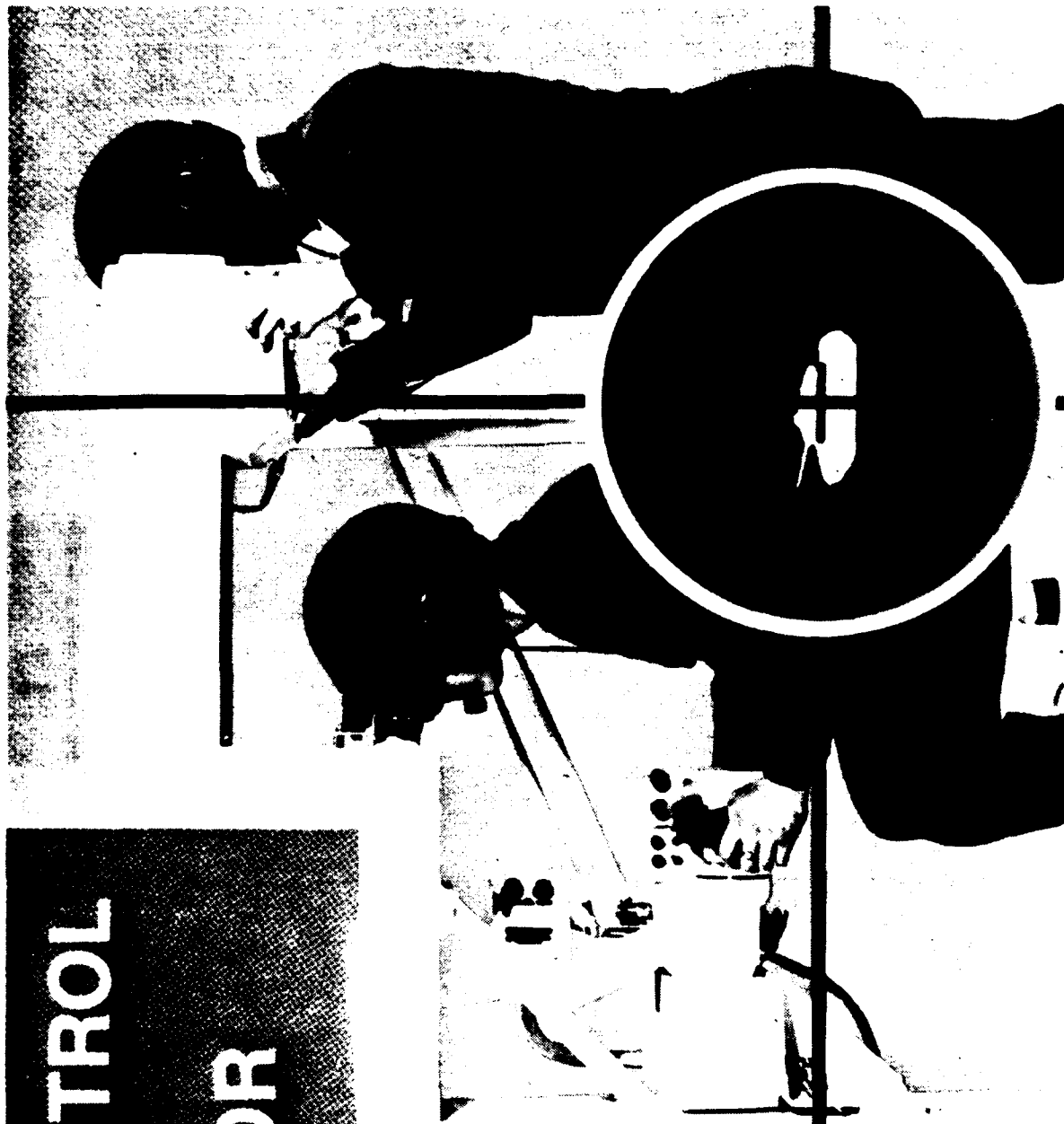
- a. Elbit fire control training procedures.
- b. Expanded result evaluation. The system generates printed reports according to customer needs. These include trainee identification, date and time of exercise, listing of effects employed, scoring by round, summary showing improvement, etc.
- c. Weather and environmental condition simulation. Appropriate filters are put in the optical path of scene image. These can also be simulated by producing views photographed under appropriate conditions.
- d. Eyepiece, reticle, and aiming controls - according to customer requirements.
- e. Additional exercises as needed.

Other customer requirements can be met by means of readily available options. Please contact Elbit for further details.

5. SPECIFICATIONS

5.1	Projected Trainee Scene	
	System resolution	0.25 milliradians
	Type of projection	Color slides
5.2	Total Viewing Area	
	Field of view	140 milliradians
	Movements:	
	Horizontal	± 70 milliradians
	Vertical	± 30 milliradians
5.3	Targets	
	Types	Various types, according to customer requirements
	Simulated range	1000 - 3000 meters
5.4	Operating Power	
	Voltage	220V ± 10%, 50Hz
	Power	500 watt (approx.)
	(Voltage rating can be changed upon customer request)	
5.5	Temperature and Humidity	
	Operating temperature range	10 - 30°C
	Storage temperature range	0 - 50°C
	Humidity	Up to 80%, non-condensing
5.6	Mechanical Dimensions (approx.)	
	Height:	
	with base	130 cm
	without base	60 cm
	Width	130 cm
	Depth	75 cm
	Weight	60 kg (without base)

FIRE CONTROL COMBAT SIMULATOR



SHARPEN GUNNERY SKILLS ...REDUCE TRAINING COSTS

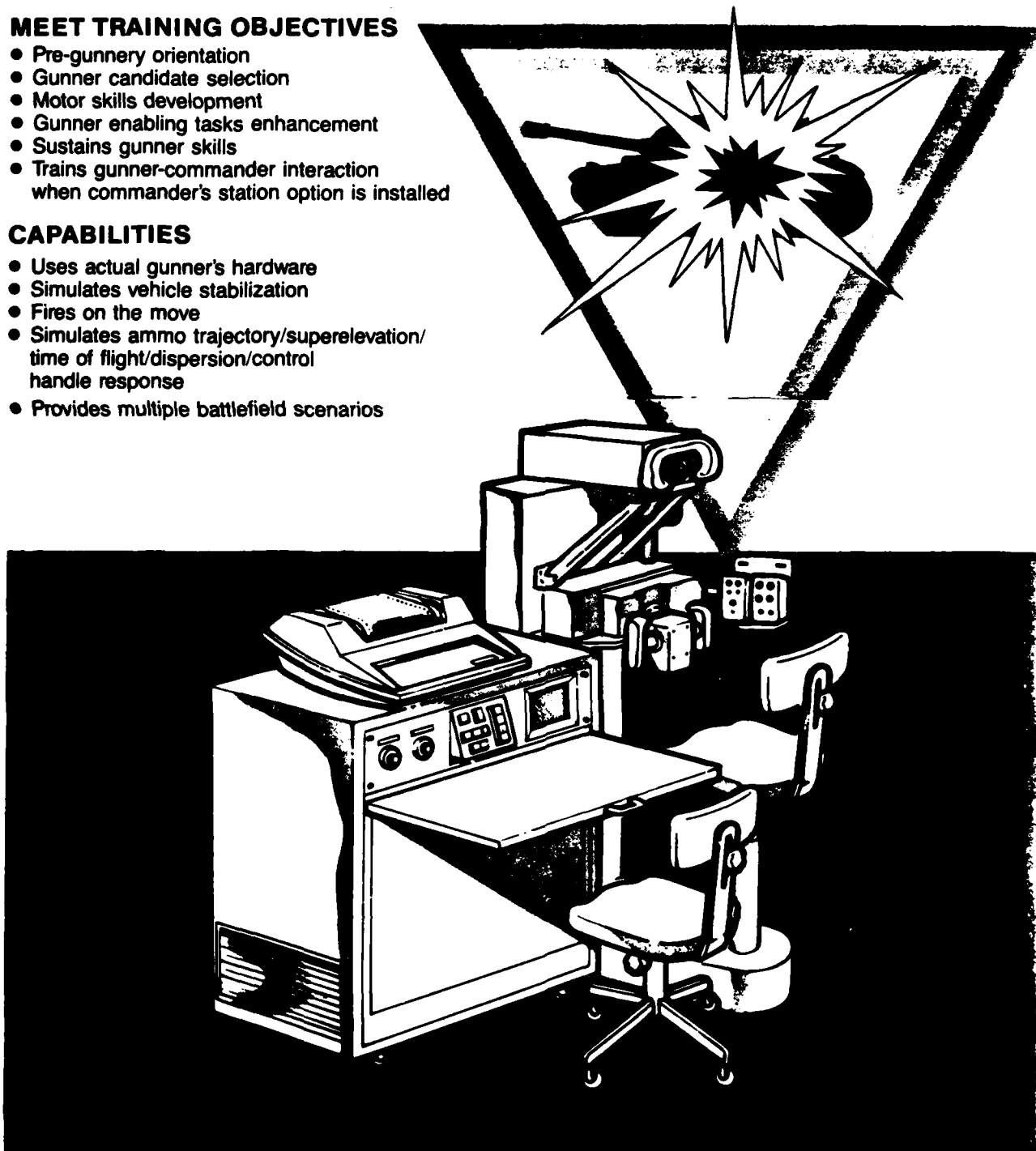
The Fire Control Combat Simulator (FCCS) offers a safe, reliable, cost effective way to develop and maintain tank gunnery proficiency. Includes an instructor's console and gunner's station. Provides training capability for the M48A5, M60A1, and M60A3 and adaptable for other vehicles upon request. Eliminates the need for live ammunition, fuel, vehicle operation and firing range real estate.

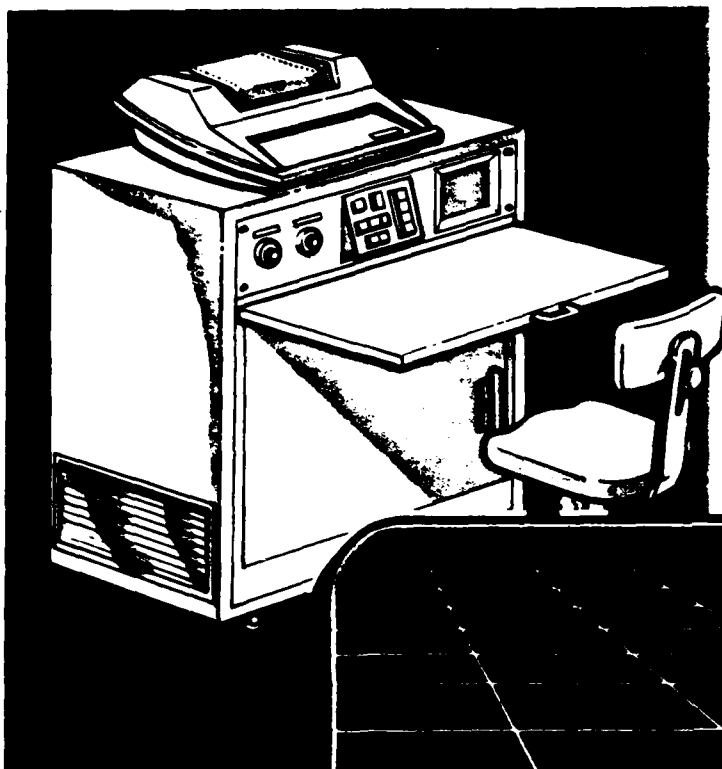
MEET TRAINING OBJECTIVES

- Pre-gunnery orientation
- Gunner candidate selection
- Motor skills development
- Gunner enabling tasks enhancement
- Sustains gunner skills
- Trains gunner-commander interaction when commander's station option is installed

CAPABILITIES

- Uses actual gunner's hardware
- Simulates vehicle stabilization
- Fires on the move
- Simulates ammo trajectory/superelevation/time of flight/dispersion/control handle response
- Provides multiple battlefield scenarios





INSTRUCTOR'S CONSOLE

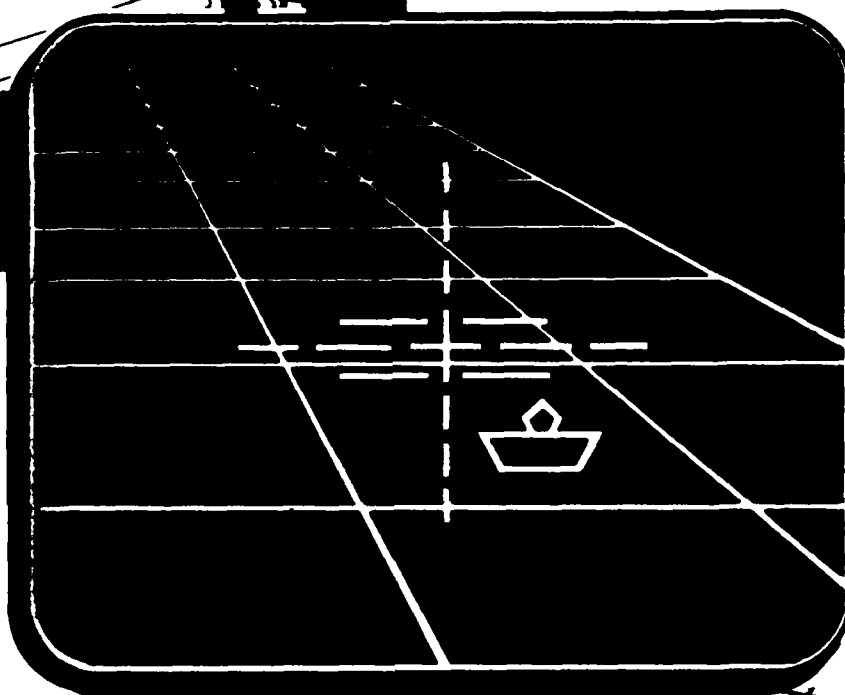
Target, terrain and type of round are programmed at the instructor's console. The console also provides control of system power and engagement start/stop commands. Visual display monitor permits assessment of the gunner's proficiency in tracking, ranging and firing. High speed printer issues a permanent hard copy record of the gunner's performance.

KEY FEATURES

- Gunner's Handles
- Periscope Eyepiece
- Ammunition Select Control
- Commander's Override Handle

KEY FEATURES

- 5" Monitor
- Control Panel
- Digital Computer
- Power Strip and Circuit Breaker
- High Speed Printer
- Power Conditioner
- Environmental Control



GUNNER & COMMANDER STATIONS

Representative of vehicle gunner's and commander's station. Uses actual tank hardware including adjustable headrest and eyepiece, control handles, control and selector switch boxes and a seat. Optional commander's station has equipment similar to the gunner's but with an override handle. Eyepiece allows target viewing including terrain and aiming reticle. Movement of the field of view to acquire, track, range, lead and fire is controlled through gunner's control handles or commander's override.



OPTIONS

1. GUNNER'S/COMMANDER'S STATION ENCLOSURE

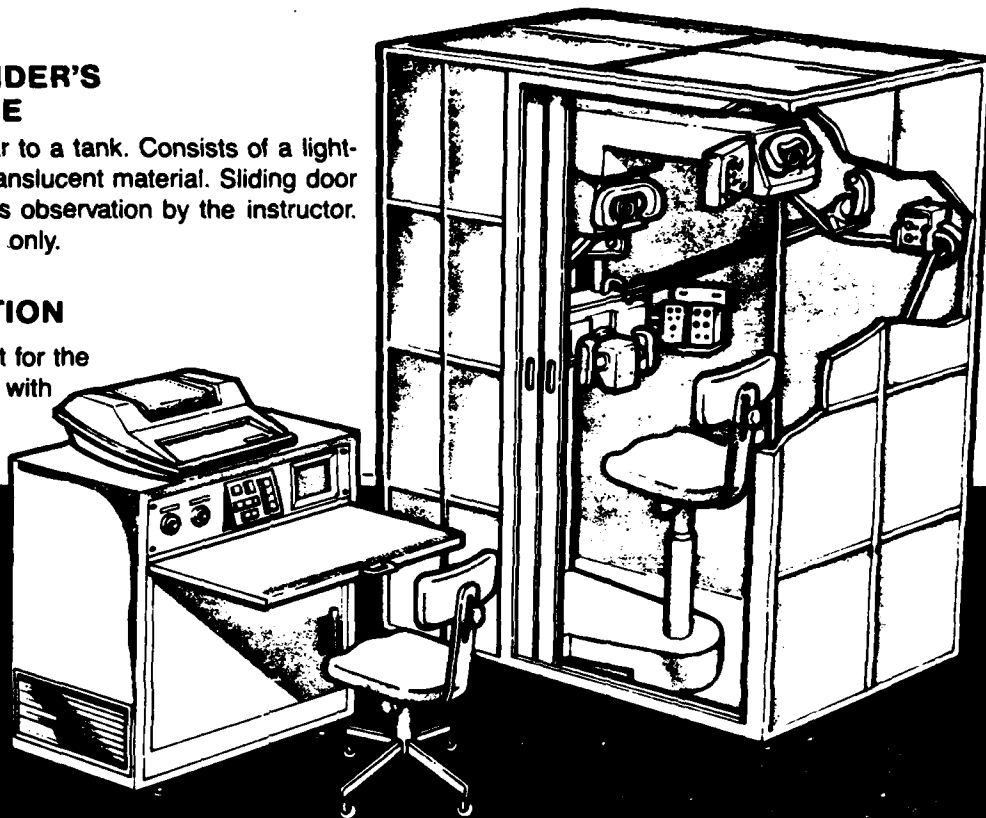
Provides space restrictions similar to a tank. Consists of a light-weight framework covered with translucent material. Sliding door provides crew access and permits observation by the instructor. Also available for gunner's station only.

2. COMMANDER'S STATION

Provides all fire control equipment for the commander student to interrelate with the gunner student.

3. SPARE PARTS KIT

Provides sufficient spare parts and components to maintain four FCCS systems at one location for one year. (Adjustable to suit customers' specific requirements.)



4. OPERATOR TRAINING

Course is one week duration. Designed to impart knowledge of functions and use of the FCCS to maximize gunnery training instruction.

5. MAINTENANCE TRAINING

Course is three weeks duration. Instruction covers theory, analysis and fault isolation on computer and data converter, diagnostic programs and documentation to include drawings, schematics and manuals. Knowledge and use of lowest replaceable component is taught through practical exercises.

TARGET TANK VARIABLES

- Range — 500 to 3500 meters
- Offset — position in azimuth
- Speed — 0 to 99 kph
- Direction — 0 to 360° in 1° increments
- Evasiveness — 0 to 9 (0 is straight line)
- View of target — full or defilade

FIRING TANK VARIABLES

- Cant — $\pm 10^\circ$
- Length of exercise — up to 360 sec.
- Speed of firing tank — 0 to 99 kph
- Terrain roughness — 0 to 9
- Ranging error — as desired
- Ammunition select — APDS, HEAT, HEP and Coax machine gun

INSTRUCTOR COMMANDS

- Go — Halt
- Short Halt
- Freeze — Resume
- Print — (prints hard copy)
- Replay — (shows last 10 impacts)
- Range

AUXILIARY EQUIPMENT

- Data loader
- Test set optional

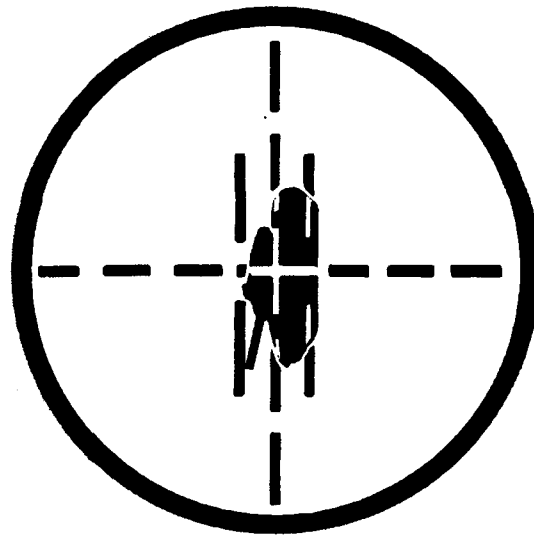
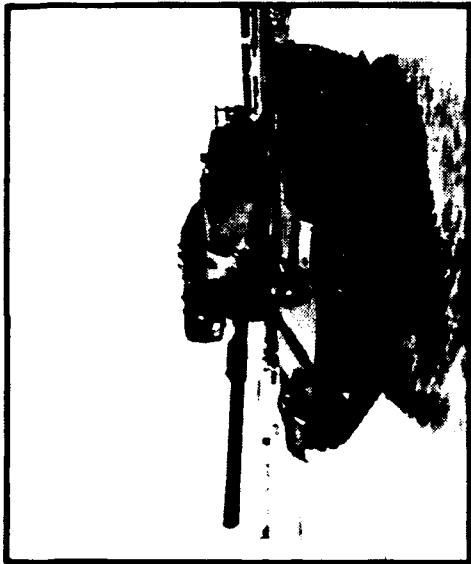
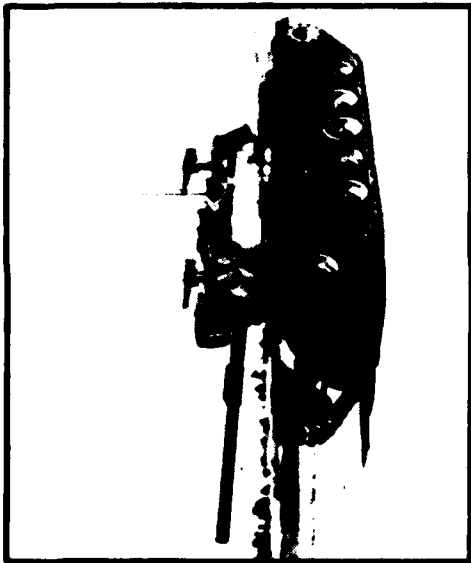
BUILT-IN CAPABILITIES

- Replay display up to 10 rounds
- Freeze during exercise
- Self-diagnostic programs for rapid fault isolation

- Air conditioning to insure system reliability
- 110 volt 60 Hz power — also available for 220 volt 50 Hz power
- Print out — permanent record for student performance
- Modular design
- Portability
- Uses standard commercial components

APPLICATIONS

- M48A5
- M60A1
- M60A3
- Adaptable to other vehicles on request



GENERAL DYNAMICS
Land Systems Division

P.O. Box 1901
Warren, Michigan 48090 U.S.A.

Printed in U.S.A.

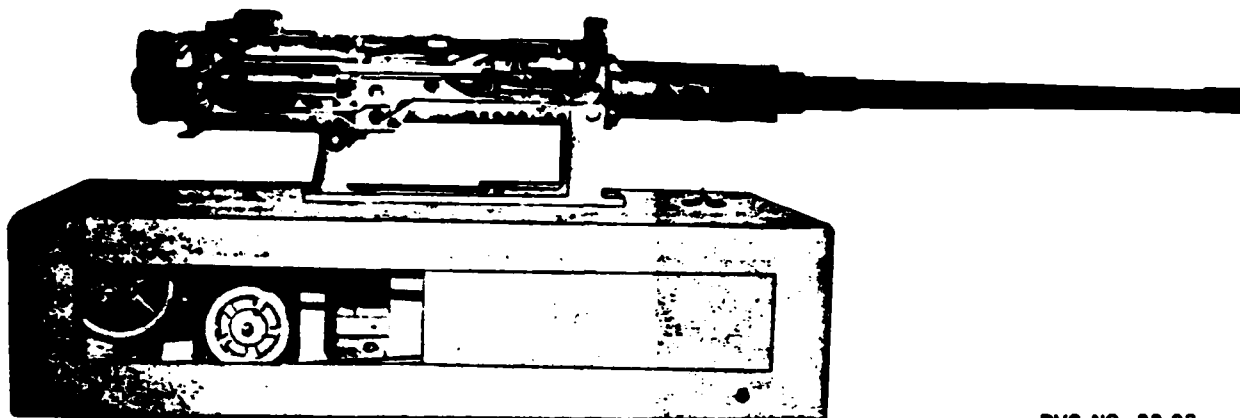
Sept. 1982

3D MOCK-UP

MOTORIZED SECTIONALIZED GUN .50 CALIBE

DVC 23-03
11D4A

NSN 6920-01-067-1684



DVC NO. 23-03

Training Category/Level Utilized:
Basic Weapons/Level 1

Logistic Responsible Command, Service, or Agency:
/PM TRADE

Source and Method of Obtaining:
Not generally available for issue (limited production).

Purpose of Trainer:
For classroom use to demonstrate the cycle of operation of the .50 Caliber M2 Machinegun.

Functional Description:
The device is a motorized, sectionalized .50 caliber machinegun with sections cut out to expose important features for easy examination by students. The firing pin spring, oil buffer spring, and bolt driving spring have been shortened to reduce the force required to drive the device. Electric motors drive the gun through slow motion firing cycles (approximately seven times per minute) while dummy ammunition is fed into the breech mechanism, demonstrating clearly the interrelationship of the working parts. Dummy cartridges that have been ejected from the chamber fall into a

compartment below the gun. Movement can be halted at any time with the motor switch, located on top of the cabinet, enabling the instructor or student to point out the relative positions of various parts at any point in the firing cycle. The gun is mounted on a cabinet assembly containing a 1/3 hp 110 vac motor. Thirty dummy cartridges and links are furnished with each gun.

Physical Information:
54" x 24" x 24"; 175 lb

Equipment Required, Not Supplied:
None

Special Installation Requirements:
None

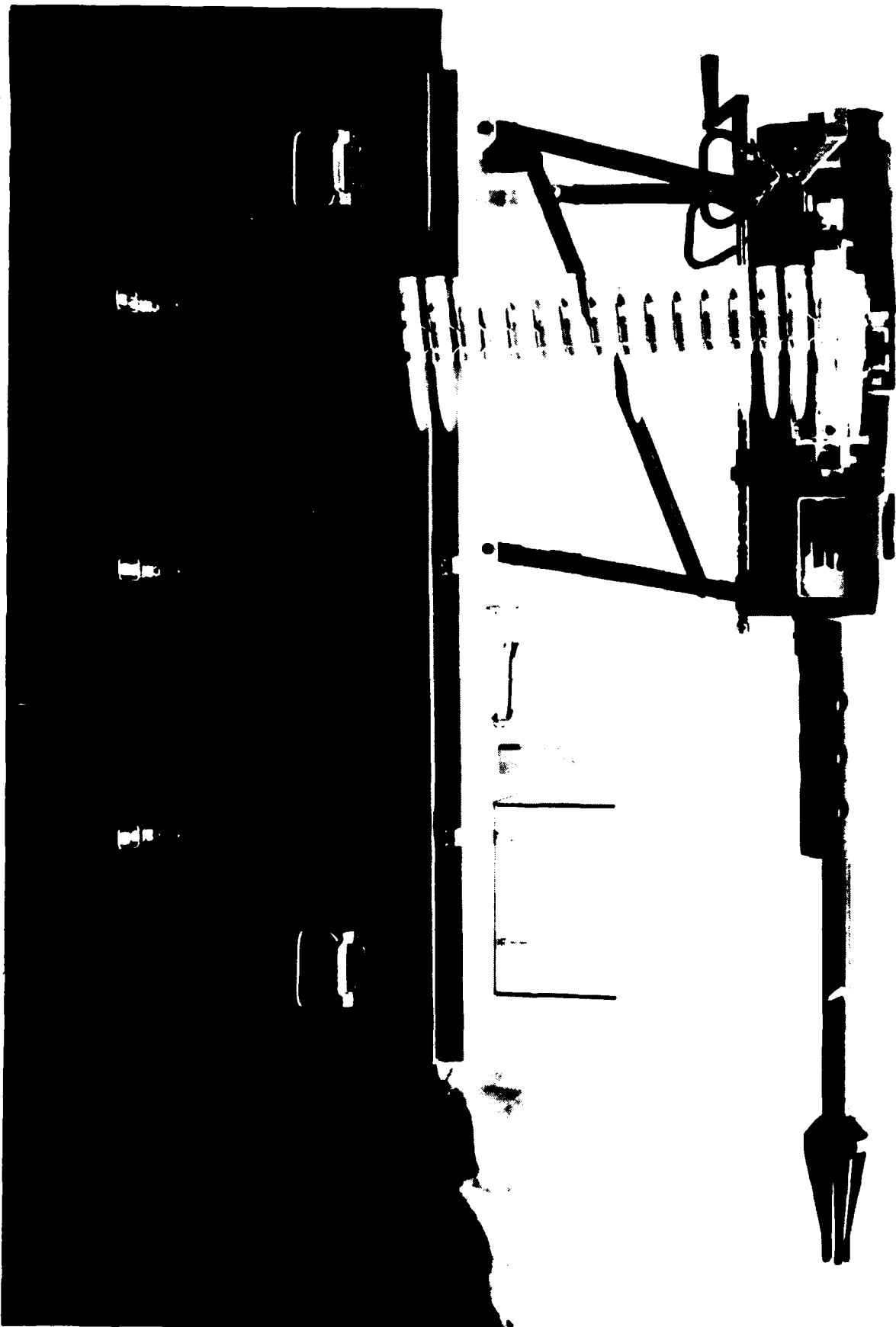
Power Requirements:
110 vac

Applicable Publications:
Maintenance Handbook for DVC 23-03

Reference Publications:
TM 9-1005-213

Device 3F85, M85
Machine Gun Mock-Up

Device 3F85 is a 1.5 to 1 scale non-firing mock-up of the M85 Machine Gun with all parts operable. Cutaway sections in selected areas permit external viewing of internal gun functions. Components are color coded to aid student comprehension of the relationship of each part to the others. Device intended for indoor or outdoor classroom usage.



DEVICE 3F85, M85 MACHINE GUN MOCK-UP

APPENDIX J

VALIDATED LAV-25 TASK LIST

APPENDIX J
VALIDATED LAV-25 TASK LIST

1. CONDUCT PLANNING

1.1 RECEIVE AND/OR ISSUE FIVE PARAGRAPH ORDER

2. PERFORM PRE-OPERATION PROCEDURES

2.1 PERFORM M242 MAIN GUN AP FEED SYSTEM LOADING PROCEDURE

2.2 PERFORM M242 MAIN GUN HE FEED SYSTEM LOADING PROCEDURE

2.3 PERFORM M240 COAX LOADING PROCEDURE

2.4 PERFORM M257 GRENADE LAUNCHER LOADING PROCEDURE

2.5 PERFORM DRY FIRE CHECKLIST (M242 MAINGUN AND M240 COAX) PROCEDURE

2.6 PLACE RADIO IN OPERATION

2.7 PERFORM RADIO TELEPHONE PROCEDURES

3. PLACE TURRET IN OPERATION

3.1 PERFORM PRE-MISSION CHECKLIST PROCEDURE

3.2 PERFORM TURRET POWER-UP PROCEDURE

3.3 PERFORM TURRET OPERATION PROCEDURES

3.4 PERFORM M242 MAIN GUN CYCLING PROCEDURE

3.5 PERFORM M242 MAIN GUN BORESIGHT PROCEDURE

3.6 PERFORM M242 MAIN GUN ZEROING PROCEDURE

3.7 PERFORM M240 COAX BORESIGHT PROCEDURE

4. OPERATE THE TURRET

4.1 PERFORM M242 MAIN GUN PRE-FIRE CHECKLIST PROCEDURES (POWERED DRIVE)

4.2 PERFORM M242 MAIN GUN PRE-FIRE CHECKLIST PROCEDURES (MANUAL DRIVE)

4.3 PERFORM M240 COAX PRE-FIRE CHECKLIST PROCEDURES (POWERED DRIVE)

4.4 PERFORM M240 COAX PRE-FIRE CHECKLIST PROCEDURES (MANUAL DRIVE)

4.5 PERFORM STAB OPERATING PROCEDURE

4.6 PERFORM M36E1 DAYSIGHT OPERATING PROCEDURE

- 4.7 PERFORM LOS DRIFT COMPENSATION PROCEDURE
- 4.8 PERFORM M36E1 NIGHTSIGHT OPERATING PROCEDURE

5. PERFORM TARGET ACQUISITION

- 5.1 SELECT/OCCUPY OBSERVATION POSITIONS
- 5.2 ASSIGN TARGET AREA RESPONSIBILITIES
- 5.3 SCAN FOR TARGETS
- 5.4 PERFORM NIGHT ACQUISITION
- 5.5 SCAN FOR TARGET IDENTIFICATION

6. EMPLOY WEAPON SYSTEM

- 6.1 ISSUE INITIAL FIRE COMMAND
- 6.2 PERFORM PRECISION FIRING SEQUENCE
- 6.3 APPLY BATTLESIGHT FIRING TECHNIQUE
- 6.4 PERFORM SENSING AND BURST ON TARGET ADJUSTMENT
- 6.5 ENGAGE TARGETS WITH M242 MAIN GUN
- 6.6 ENGAGE TARGETS WITH M240 COAX MACHINE GUN
- 6.7 EMPLOY M257 GRENADE LAUNCHER
- 6.8 SELECT AND OCCUPY FIRING POSITIONS

7. PERFORM IMMEDIATE ACTION PROCEDURES

- 7.1 STOP RUNAWAY TURRET
- 7.2 REDUCE M242 MAIN GUN FAILURE TO FIRE
- 7.3 PERFORM M242 MAIN GUN MISFIRE PROCEDURE (COOL GUN)
- 7.4 PERFORM M242 MAIN GUN MISFIRE PROCEDURE (HOT GUN)
- 7.5 PERFORM SAFETY PROCEDURES WHEN HOT M242 MAIN GUN FAILS TO FIRE AND
BOLT POSITION INDICATOR IN POSITION OTHER THAN SEAR AND MISFIRE
- 7.6 PERFORM IMMEDIATE ACTION TO CLEAR JAMMED MAIN GUN
- 7.7 STOP RUNAWAY M240 COAX
- 7.8 REDUCE M240 COAX GUN FAILURE TO FIRE (HOT GUN)
- 7.9 PERFORM M240 COAX MISFIRE PROCEDURE
- 7.10 REDUCE M257 GRENADE LAUNCHER FAILURE TO LAUNCH
- 7.11 PERFORM EMERGENCY TURRET POWER-DOWN PROCEDURE
- 7.12 PERFORM LOW AMMO OVERRIDE PROCEDURE

8. PERFORM POST-OPERATING PROCEDURES

- 8.1 PERFORM M242 MAIN GUN DOWNLOADING PROCEDURE
- 8.2 PERFORM M240 COAX DOWNLOADING PROCEDURE
- 8.3 PERFORM M257 GRENADE LAUNCHER DOWNLOADING PROCEDURE
- 8.4 PERFORM TURRET POWER-DOWN PROCEDURE
- 8.5 PERFORM POST-MISSION CHECKLIST PROCEDURE
- 8.6 MAINTAIN WEAPONS RECORD DATA/GUN BOOK ON M240/M242/M257
- 8.7 MAINTAIN VEHICLE LOGBOOKS
- 8.8 INITIATE VEHICLE WORK ORDERS

9. PERFORM PREVENTIVE MAINTENANCE (PM)

- 9.1 CLEAN, INSPECT, LUBRICATE M242 MAIN GUN
- 9.2 CLEAN, INSPECT, LUBRICATE M240 COAX
- 9.3 PERFORM M257 GRENADE LAUNCHER PM
- 9.4 PERFORM PM ON OPTICS
- 9.5 PERFORM PM ON WIRING HARNESSSES
- 9.6 PERFORM PM ON HYDRAULIC SYSTEM
- 9.7 PERFORM PM ON FIRE CONTROL EQUIPMENT
- 9.8 PERFORM PM ON DOME LIGHTS
- 9.9 PERFORM PM ON SEATS
- 9.10 PERFORM PM ON TURRET CREW STATIONS
- 9.11 PERFORM PM ON WEAPON ENCLOSURE BAG
- 9.12 PERFORM PM ON M242 MAIN GUN AP AND HE FEED CHUTES
- 9.13 PERFORM PM ON M242 MAIN GUN AP AND HE LINK EJECTION CHUTES
- 9.14 PERFORM PM ON M240 COAX FEED CHUTE
- 9.15 PERFORM PM ON M240 COAX LINK EJECTION CHUTE

10. PERFORM REMOVAL AND INSTALLATION PROCEDURES

- 10.1 PERFORM M242 MAIN GUN REMOVAL PROCEDURE
- 10.2 PERFORM M242 MAIN GUN INSTALLATION PROCEDURE
- 10.3 PERFORM M240 COAX REMOVAL, DISASSEMBLY, ASSEMBLY AND INSTALLATION PROCEDURES
- 10.4 PERFORM M36E1 SIGHT (GUNNERS AND COMMANDERS) REMOVAL/INSTALLATION PROCEDURES

11. PERFORM OPERATOR TROUBLESHOOTING PROCEDURES

- 11.1 TROUBLESHOOT M242 MAIN GUN FAILURE TO FIRE
- 11.2 TROUBLESHOOT M240 COAX FAILURE TO FIRE
- 11.3 TROUBLESHOOT M257 GRENADE LAUNCHER FAILURE TO LAUNCH
- 11.4 CYCLE M242 BOLT TO SEAR, FEEDER INSTALLED
- 11.5 CYCLE M242 BOLT TO SEAR, FEEDER REMOVED
- 11.6 TIME M242

MISSION ORIENTED LAV TURRET TASK LISTING

1. CONDUCT PLANNING

1.1 RECEIVE AND/OR ISSUE FIVE PARAGRAPH ORDER.

2. PERFORM PRE-OPERATION PROCEDURES

2.1 PERFORM M242 MAIN GUN AP FEED SYSTEM LOADING PROCEDURE.

2.1.1 Turn TURRET POWER circuit breaker OFF.

2.1.2 Verify TURRET PWR indicator not lit.

2.1.3 Turn TURRET DRIVE LOCK to LOCK position.

WARNING

Loading procedures requires working from inside of vehicle through the turret opening. To prevent injury to personnel or damage to equipment, ensure that TURRET POWER circuit breaker remains in OFF position and TURRET DRIVE LOCK remains at LOCK position while working through turret opening.

2.1.4 Turn WEAPON POWER circuit breaker OFF.

2.1.5 Verify WEAPON PWR indicator not lit.

2.1.6 Set WEAPON ARM switch to SAFE.

2.1.7 Place M242 manual safety on SAFE (crosswise).

2.1.8 Remove all links from the AP link chute.

2.1.9 Perform feeder removal and installation procedure and verify that the weapon is clear prior to loading ammunition.

2.1.10 Verify that both ends of AP feed chute are latched in place.

2.1.11 Verify that the bolt position indicator pointer is at SEAR.

2.1.12 Rotate knob on M242 vertical drive shaft back and forth to verify that the weapon bolt assembly is in SEAR. Drive shaft must meet resistance in both directions.

- 2.1.13 Push feed select solenoid on M242 to AP position (IN).
- 2.1.14 Open AP ammo box cover on forward compartment of ready box.
- 2.1.15 Load AP ammo into the ready box with the projectile toward the Commander's station.
 - 2.1.15.1 Put the double claw end of the belt into the forward section of the compartment (link face down) and fold the belt to fill the compartment.
- 2.1.16 Connect succeeding belts as needed.
- 2.1.17 Route the single-claw end of a belt into the forwarder with the link side up.
- 2.1.18 Use the 14mm ratchet wrench on the forwarder to route the ammo belt up the feed chute.
 - 2.1.18.1 Continue until the lead round is in the upper feed sprocket.
- 2.1.19 Place 14mm wrench on upper feed sprocket extension and rotate in direction of arrow on feeder until the feed chute stop clicks once.

NOTE

If unable to successfully accomplish 2.1.19, return wrench to forwarder and ensure lead round is in the upper feed sprocket.

- 2.1.20 Close AP ammo box cover and secure.
 - 2.1.21 Stow 14mm ratchet wrench.
 - 2.1.22 Verify that weapons enclosure bag is properly secured around weapons, feed chutes, and top of rotor.
 - 2.1.23 Set TURRET DRIVE LOCK to UNLOCK position.
 - 2.1.24 Sound alert "POWER." Position TURRET POWER and WEAPON POWER circuit breakers to ON.
 - 2.1.25 Verify TURRET PWR and WEAPON PWR indicators lit.
- 2.2 PERFORM M242 MAIN GUN HE FEED SYSTEM LOADING PROCEDURE.
- 2.2.1 Turn TURRET POWER circuit breaker OFF.
 - 2.2.2 Verify TURRET PWR indicator not lit.
 - 2.2.3 Turn TURRET DRIVE LOCK in LOCK position.

WARNING

Loading procedures requires working from inside of vehicle through the turret opening. To prevent injury to personnel or damage to equipment, ensure that TURRET POWER circuit breaker remains in OFF position and TURRET DRIVE remains at LOCK position while working through turret opening.

- 2.2.4 Turn WEAPON POWER circuit breaker OFF.
- 2.2.5 Verify WEAPON PWR indicator not lit.
- 2.2.6 Position WEAPON ARM switch to SAFE.
- 2.2.7 Place M242 manual safety on SAFE (crosswise).
- 2.2.8 Remove all links from the HE link chute.
- 2.2.9 Perform feeder removal and installation procedure and verify that the weapon is clear prior to loading ammunition.
- 2.2.10 Verify that both ends of HE feed chute are latched in place.
- 2.2.11 Verify that the bolt position indicator pointer is at SEAR.
- 2.2.12 Rotate knob on M242 vertical drive shaft back and forth to verify that the weapon bolt assembly is in SEAR. Drive shaft must meet resistance in both directions.
- 2.2.13 Pull the feed select solenoid to HE position (OUT).
- 2.2.14 Remove HE ammo box cover from rear compartment of ready box.
- 2.2.15 Load HE ammo into the ready box with the projectile toward the Commander's station.
 - 2.2.15.1 Put the single-claw end of the belt into the forward compartment of the ready box. Fold the belt to fill that compartment (ammo face down). After the front compartment is full, fill the second and rear compartments in sequence.
- 2.2.16 Connect succeeding belts as needed.

- 2.2.17 Route the double-claw end of a belt, with a round in and link side up, into the forwarder.
- 2.2.18 Use the 14mm ratchet wrench on the forwarder to route the ammo belt up the feed chute.
 - 2.2.18.1 Continue until the lead round is in the lower feed sprocket.
- 2.2.19 Place 14mm wrench on lower feed sprocket extension and rotate in direction of arrow on feeder until the feed chute stop clicks twice.

NOTE

If unable to successfully accomplish 2.2.19, return wrench to forwarder and ensure lead round is in the upper feed sprocket.

- 2.2.20 Close HE ammo box cover and secure.
 - 2.2.21 Stow the 14mm ratchet wrench.
 - 2.2.22 Verify that weapons enclosure bag is properly secured around weapons, feed chutes, and top of rotor.
 - 2.2.23 Set TURRET DRIVE LOCK handle to UNLOCK position.
 - 2.2.24 Sound alert "POWER." Position TURRET PWR and WEAPON PWR circuit breakers to ON.
 - 2.2.25 Verify TURRET PWR and WEAPON PWR indicators lit.
- 2.3 PERFORM M240 COAX LOADING PROCEDURE.
- 2.3.1 Turn TURRET POWER circuit breaker OFF.
 - 2.3.2 Verify TURRET PWR indicator not lit.
 - 2.3.3 Turn TURRET DRIVE LOCK handle to LOCK.

WARNING

Loading procedure requires working from inside of vehicle through turret opening. To prevent injury to personnel or damage to equipment, ensure that TURRET POWER circuit breaker remains in OFF position and TURRET DRIVE LOCK remains at LOCK position while working through turret opening.

- 2.3.4 Set WEAPON POWER circuit breaker to OFF position.
- 2.3.5 Verify WEAPON PWR indicator not lit.
- 2.3.6 Position WEAPON ARM switch to SAFE.
- 2.3.7 Charge M240, set weapon manual safety to S (safe) position.
- 2.3.8 Load 7.62mm ammo into front compartment of ammo box with projectile pointing outboard, double claw end of belt against forward wall of compartment, solid side of link down and round up.

NOTE

Additional ammo belts will be connected, as needed, until ammo box is full.

- 2.3.9 Fold ammo belt back and forth until front compartment of ammo box is full, then fill center and rear compartments in sequence using same loading pattern.

NOTE

If end of ammo belt from previous loading is folded over ammo forwarder, proceed to step 2.3.17.

- 2.3.10 Pull weapon charging handle to rear.
- 2.3.11 Push in cover latches and open weapon cover.
- 2.3.12 Raise feed tray.

- 2.3.13 Visually and physically inspect chamber to ensure that no round is chambered.
 - 2.3.14 Lower feed tray.
 - 2.3.15 Take an ammo belt that is not connected to ammo belts in ammo box and manually insert double claw end of belt (with solid side of link up and round down) into feedchute at forward end of ammo box.
 - 2.3.16 Manually slide belt through feed chute until first round reaches cartridge stop at weapon.
 - 2.3.17 Close weapon cover.
 - 2.3.18 Connect ammo belt in ammo box to end of ammo belt in ammo chute.
 - 2.3.19 Set weapon manual safety to F (Fire) position.
 - 2.3.20 Turn TURRET DRIVE LOCK to UNLOCK position.
 - 2.3.21 Sound alert "POWER." Turn TURRET POWER and WEAPON POWER circuit breakers to ON position.
 - 2.3.22 Verify TURRET PWR and WEAPON PWR indicators lit.
- 2.4 PERFORM M257 GRENADE LAUNCHER LOADING PROCEDURE.
- 2.4.1 Turn TURRET POWER circuit breaker OFF.
 - 2.4.2 Verify TURRET PWR indicator not lit.
 - 2.4.3 Turn TURRET DRIVE LOCK to LOCK position.
 - 2.4.4 Turn WEAPON POWER circuit breaker OFF.
 - 2.4.5 Verify WEAPON PWR indicator not lit.
 - 2.4.6 Turn LEFT SALVO switch OFF.
 - 2.4.7 Turn RIGHT SALVO switch OFF.
 - 2.4.8 Remove and store four protective covers from each launcher.
 - 2.4.9 Verify that each launcher barrel is free of contamination and contacts are clear.
 - 2.4.10 Insert a grenade in a barrel electrical contacts first.

WARNING

When loading L5 smoke grenades, keep your body, head, fingers, etc., out of the direct line of the barrel as the grenade is inserted.

- 2.4.11 Rotate the grenade at least a quarter turn to insure electrical contact.
- 2.4.12 Repeat steps 2.4.10 and 2.4.11 for remaining barrels.
- 2.4.13 Turn TURRET DRIVE LOCK to UNLOCK position.
- 2.4.14 Sound alert "POWER." Turn TURRET POWER and WEAPON POWER circuit breakers to ON position.
- 2.4.15 Verify TURRET PWR and WEAPN PWR indicators lit.
- 2.5 PERFORM DRY FIRE CHECKLIST (M242 MAIN GUN AND M240 COAX) PROCEDURE.
 - 2.5.1 Ensure appropriate vehicle hatches closed and locked.
 - 2.5.2 Place M242 safety to SAFE (crosswise).
 - 2.5.3 Charge M240, set weapon manual safety to S (Safe) position.
 - 2.5.4 Turn TURRET DRIVE LOCK to LOCK position.
 - 2.5.5 Sound alert "POWER"; set TURRET POWER, WEAPON POWER, and AUXILIARY POWER circuit breakers to ON position.
 - 2.5.6 Verify that TURRET PWR, WEAPON PWR and AUX PWR indicators are lit.
 - 2.5.7 Set WEAPON ARM switch to ARM.
 - 2.5.8 Position DRIVE SELECT lever up for power mode.
 - 2.5.9 Position gunner's MAIN/COAX switch to MAIN.
 - 2.5.10 Verify "MAIN" indicator lit.
 - 2.5.11 Verify MAIN GUN "SEAR" indicator lit.
 - 2.5.12 Position gunner's AP/HE switch to AP.
 - 2.5.13 Verify "AP" indicator lit.
 - 2.5.14 Push LOW AMMO OVERRIDE switch to ON.
 - 2.5.15 Position gunner's 200/100/SS switch to SS.
 - 2.5.16 Verify "SS" indicator lit.
 - 2.5.17 Squeeze gunner's palm switch.
 - 2.5.18 Lift trigger guard, squeeze gunner's trigger.
 - 2.5.19 Verify bolt position indicator at MISFIRE.
 - 2.5.20 Verify MISFIRE RESET WARNING indicator lit.
 - 2.5.21 Press MISFIRE RESET WARNING indicator.
 - 2.5.22 Lift trigger guard, squeeze gunner's trigger.
 - 2.5.23 Verify bolt position indicator at SEAR.
 - 2.5.24 Position gunner's AP/HE switch to HE.
 - 2.5.25 Verify HE indicator lit.
 - 2.5.26 Push LOW AMMO OVERRIDE switch to ON.

- 2.5.27 Lift trigger guard, squeeze gunner's trigger.
- 2.5.28 Verify bolt position indicator at MISFIRE.
- 2.5.29 Verify MISFIRE RESET WARNING indicator lit.
- 2.5.30 Press MISFIRE RESET WARNING indicator.
- 2.5.31 Lift trigger guard, squeeze gunner's trigger.
- 2.5.32 Verify bolt position indicator at SEAR.
- 2.5.33 Position gunner's MAIN/COAX switch to COAX.
- 2.5.34 Verify COAX indicator lit.
- 2.5.35 Position COAX manual safety to F (Fire).
- 2.5.36 Pull charging handle to rear and hold.
- 2.5.37 Lift trigger guard, squeeze gunner's trigger.
- 2.5.38 Slowly release charging handle and ride bolt forward.
- 2.5.39 Release gunner's palm switch.
- 2.5.40 Repeat steps 2.5.9 through 2.5.39 using Commander's hand control.
- 2.5.41 Position DRIVE SELECT lever down for manual mode.
- 2.5.42 Position gunner's MAIN/COAX switch to MAIN.
- 2.5.43 Verify MAIN indicator lit.
- 2.5.44 Position gunner's 200/100/SS switch to SS.
- 2.5.45 Verify SS indicator lit.
- 2.5.46 Push LOW AMMO OVERRIDE switch to ON.
- 2.5.47 Press auxiliary trigger on elevation handcrank.
- 2.5.48 Verify bolt position indicator at MISFIRE.
- 2.5.49 Verify MISFIRE RESET WARNING indicator lit.
- 2.5.50 Press MISFIRE RESET WARNING indicator.
- 2.5.51 Press auxiliary trigger on elevation handcrank.
- 2.5.52 Verify bolt position indicator at SEAR.
- 2.5.53 Position gunner's MAIN/COAX switch to COAX.
- 2.5.54 Verify COAX indicator lit.
- 2.5.55 Push LOW AMMO OVERRIDE switch to ON.
- 2.5.56 Pull charging handle to rear and hold.
- 2.5.57 Press auxiliary trigger on elevation handcrank.
- 2.5.58 Slowly release charging handle and ride bolt forward.
- 2.5.59 Pull the COAX charging handle to the rear and hold.
- 2.5.60 Pull COAX manual trigger.
- 2.5.61 Slowly release charging handle and ride bolt forward.

2.5.62 Repeat steps 2.5.42 through 2.5.61 using commander's hand control.

2.5.63 Charge COAX and position manual safety to S (Safe).

2.6 PLACE RADIOS IN OPERATION.

HS - TBD

2.7 PERFORM RADIO TELEPHONE PROCEDURES.

HS - TBD

3. PLACE TURRET IN OPERATION

3.1 PERFORM PRE-MISSION CHECKLIST.

- 3.1.1 Turn TURRET DRIVE LOCK to LOCK position.
- 3.1.2 Check electrical harness for frayed wires and disconnected connectors.
- 3.1.3 Check hydraulic components for leaks.
- 3.1.4 Check hydraulic fluid reservoir level.
- 3.1.5 Check pop-up indicator on hydraulic fluid filter assembly. If up notify organizational maintenance.
- 3.1.6 Check Commander's and Gunner's sights and vision blocks .
- 3.1.7 Check gunner's nightsight power switch off.
- 3.1.8 Check gunner's nightsight RETICLE brightness control off.
- 3.1.9 Check Commander's nightsight power switch off.
- 3.1.10 Check Commander's nightsight RETICLE brightness control off.
- 3.1.11 Boresight knobs and diopter ring checked for movement.
- 3.1.12 Main gun and feed system checked.
 - 3.1.12.1 Main Gun manual safe ON (crosswise).
 - 3.1.12.2 Main Gun in SEAR.
 - 3.1.12.3 Feed Chutes in place.
 - 3.1.12.4 Link Chutes in place and clear.
- 3.1.13 Close and latch A.P. ammo cover.
- 3.1.14 Close and latch H.E. ammo cover.
- 3.1.15 Coax gun and feed system checked.
 - 3.1.15.1 Coax on safe.
 - 3.1.15.2 Feed chute in place.
 - 3.1.15.3 Link chute in place and clear.
- 3.1.16 Radio and intercom off.
- 3.1.17 Adjust seat.

3.2 PERFORM TURRET POWER-UP PROCEDURE.

- 3.2.1 Perform PRE-MISSION CHECKLIST.
- 3.2.2 Turn vehicle MASTER switch on.
- 3.2.3 Turn AUXILIARY POWER circuit breaker ON.
- 3.2.4 Verify that AUXILIARY PWR indicator is lit.

- 3.2.5 Turn TURRET POWER circuit breaker ON.
- 3.2.6 Verify that TURRET PWR indicator is lit.

NOTE

Electrical power is now available to entire turret.

- 3.2.7 Push lamp test switch to ON. Verify all lights functioning. Replace bulbs as necessary.
- 3.2.8 Turn TURRET DRIVE LOCK to UNLOCK.
- 3.2.9 Position DRIVE SELECT lever up for power mode.

WARNING

Verify that the vehicle is clear for turret operation, otherwise injuries to personnel or damage to equipment may occur.

- 3.2.10 Close palm switch.
- 3.2.11 Use both hand controls to drive gun and turret.

CAUTION

Turret operators are responsible for gun and bustle overhang during mobile operation.

3.3 PERFORM TURRET OPERATION PROCEDURES.

- 3.3.1 Perform PRE-MISSION CHECKLIST.
- 3.3.2 Perform TURRET POWER-UP PROCEDURE.
- 3.3.3 Turn radio switch ON.
- 3.3.4 Turn intercom switch ON.
- 3.3.5 Perform ICS and radio checks.
- 3.3.6 Turn vent switch on to check vent operation.
- 3.3.7 Position DRIVE SELECT lever down for manual mode.
- 3.3.8 Rotate elevation handcrank to move guns up and down.

- 3.3.9 Rotate azimuth handwheel to rotate turret clockwise and counterclockwise.
 - 3.3.10 Position DRIVE SELECT lever up for POWER mode.
 - 3.3.11 Perform CDU Lamp Test.
 - 3.3.12 Close Gunner's palm switch.
 - 3.3.13 Verify hydraulic pump operating.
 - 3.3.14 Elevate Main gun from Gunner's hand control.
 - 3.3.15 Traverse Turret from Gunner's hand control.
 - 3.3.16 Elevate Main gun from Commander's hand control.
 - 3.3.17 Traverse Turret from Commander's hand control.
 - 3.3.18 Turn WEAPON POWER circuit breaker ON.
 - 3.3.19 Verify WEAPON PWR indicator lit.
 - 3.3.20 Set WPN ARM switch to ARM.
 - 3.3.21 Perform DRY FIRE CHECKLIST.
 - 3.3.22 Perform STAB OPERATING PROCEDURE.
- 3.4 PERFORM M242 MAIN GUN CYCLING PROCEDURE
- 3.4.1 Perform M242 uploading procedures (2.1 and 2.2).
 - 3.4.2 Place M242 safety to SAFE (crosswise).
 - 3.4.3 Sound alert "POWER"; set TURRET POWER, WEAPON POWER and AUX POWER circuit breakers to ON position.
 - 3.4.4 Verify that TURRET POWER, WEAPON POWER and AUX POWER indicators are lit.
 - 3.4.5 Set WEAPON ARM switch to ARM.
 - 3.4.6 Position DRIVE SELECT lever up for power mode.
 - 3.4.7 Position gunner's MAIN/COAX switch to MAIN.
 - 3.4.8 Verify "MAIN" indicator is lit.
 - 3.4.9 Verify MAIN GUN "SEAR: indicator is lit.
 - 3.4.10 Position gunner's AP/HE switch to AP.
 - 3.4.11 Verify "AP" indicator is lit.
 - 3.4.12 Position gunner's 200/100/SS switch to SS.
 - 3.4.13 Verify "SS" indicator is lit.
 - 3.4.14 Squeeze gunner's palm switch.
 - 3.4.15 Lift trigger guard, squeeze gunner's trigger.
 - 3.4.16 Verify bolt position indicator at MISFIRE.
 - 3.4.17 Verify MISFIRE RESET warning indicator is lit.
 - 3.4.18 Press MISFIRE RESET WARNING indicator.

- 3.4.19 Lift trigger guard, squeeze gunner's trigger.
- 3.4.20 Verify bolt position indicator at SEAR.

NOTE

Main Gun is now ready to fire. Place safety on
FIRE when ready to continue engagement.

3.5 PERFORM M242 MAIN GUN BORESIGHTING PROCEDURE

- 3.5.1 Locate a target at 1000 meters.
- 3.5.2 Place vehicle on level surface.
- 3.5.3 Install 25mm adapter, boresight device and streamer.
- 3.5.4 Driver looks through boresight device and gives directions to the gunner to lay boresight cross to aiming point of target.
- 3.5.5 Gunner moves gun manually as directed by driver.
- 3.5.6 Driver rotates boresight device 180° degrees to check boresight alignment.

NOTE

Personnel in or on LAV should remain stationary
during boresight alignment.

- 3.5.7 Verify gunner's sight is properly installed and secure.
- 3.5.8 Adjust gunner's M36E1 daylight boresight knobs to align boresight cross on target.
- 3.5.9 Rotate boresight knob collars so that number (4) four is on the index mark.
- 3.5.10 Repeat steps 3.5.7 through 3.5.9 for commander's daysight.
- 3.5.11 Remove the 25mm adaptor, boresight device and streamer and stow in proper compartment.

3.6 PERFORM M242 MAIN GUN ZEROING PROCEDURE

- 3.6.1 Perform boresight alignment procedures.
- 3.6.2 Identify a target at a known range (1000 meters).
- 3.6.3 Perform AP and HE uploading procedures.

- 3.6.4 Select aiming point on target.
- 3.6.5 Cycle the M242 to load the gun. (MISFIRE RESET light goes off).
- 3.6.6 Select proper range line on reticle to correspond to the known range to the target.
- 3.6.7 Use manual elevation handcrank and traversing handwheel to lay the proper range line on the target aiming point.
- 3.6.8 Fire one round at the target.
- 3.6.9 Manually relay on target and fire one round.
- 3.6.10 Repeat Step 3.6.9 until 3 to 5 rounds have been fired.
- 3.6.11 Relay on same aiming point. (Do not fire.)
- 3.6.12 Adjust reticle boresight knobs to move reticle range line to center-of-impact.
- 3.6.13 Relay on target and fire one check round.
- 3.6.14 Verify that check round is within tolerance TBD inches.

NOTE

If check round is not within tolerance repeat steps 3.6.9 - 3.6.13. If it still does not come within tolerance, notify organizational maintenance.

- 3.6.15 Using manual elevation handcrank and traversing handwheel, relay gunner's boresight cross on an identifiable aiming point.
- 3.6.16 Using boresight knobs, adjust commander's M-36E1 boresight cross to the same identifiable aiming point as gunner's boresight cross is on.
- 3.6.17 Record boresight knob setting, ammo, and range, in vehicle logbook.

3.7 PERFORM M-240 COAX BORESIGHT PROCEDURE.

NOTE

During the procedure, DO NOT move the boresight knobs.

- 3.7.1 Perform M242 boresight alignment procedure.
- 3.7.2 Perform M242 zeroing procedure.
- 3.7.3 Place vehicle on level surface.
- 3.7.4 Locate a target at Known Range (recommended 800 meters).
- 3.7.5 Perform Main gun Clearing procedure.
- 3.7.6 Install 7.62mm adapter, boresight device and streamer into muzzle of coax.
- 3.7.7 Move gun manually to lay the gunner's M36E1 boresight cross on an identifiable target aiming point.
- 3.7.8 Driver looks through boresight device and uses 14mm ratchet wrench on COAX mount boresight drive nuts to adjust deflection and elevation to the selected aiming point of the M36E1 boresight cross.

CAUTION

Deflection must be adjusted before elevation due to the configuration of the gun mount.

- 3.7.9 Remove 7.62 adapter, boresight, device and streamer and stow in proper compartment.

NOTE

COAX is now boresighted.

4. OPERATE THE TURRET

4.1 PERFORM M242 MAIN GUN PRE-FIRE CHECKLIST PROCEDURES (POWERED DRIVE).

- 4.1.1 Verify appropriate vehicle hatches closed and locked.
- 4.1.2 Turn AUXILIARY POWER circuit breaker ON.
- 4.1.3 Verify AUX PWR indicator lit.
- 4.1.4 Place safety to FIRE (inline).
- 4.1.5 Position DRIVE SELECT lever up for power mode.
- 4.1.6 Turn TURRET POWER circuit breaker ON.
- 4.1.7 Verify TURRET PWR indicator lit.
- 4.1.8 Position appropriate MAIN/COAX switch MAIN.
- 4.1.9 Verify MAIN GUN indicator lit.
- 4.1.10 Turn WEAPON POWER circuit breaker ON.
- 4.1.11 Verify WEAPON PWR indicator lit.
- 4.1.12 Set WEAPON ARM switch to ARM.
- 4.1.13 Verify appropriate LOW AMMO indicator not lit.
- 4.1.14 Verify MAIN GUN "SEAR" indicator lit.
- 4.1.15 Position AP/HE switch as appropriate.
- 4.1.16 Verify appropriate AP/HE indicator lit.
- 4.1.17 Position 200/100/SS switch as appropriate.
- 4.1.18 Verify appropriate 200/100/SS indicator lit.

NOTE

Weapon ready to fire from hand control.

4.2 PERFORM M242 MAIN GUN PRE-FIRE CHECKLIST PROCEDURES (MANUAL DRIVE).

- 4.2.1 Verify appropriate vehicle hatches closed and locked.
- 4.2.2 Position AUXILIARY POWER circuit breaker to ON.
- 4.2.3 Verify AUX PWR indicator lit.
- 4.2.4 Place safety to FIRE (inline).
- 4.2.5 Position DRIVE SELECT lever down for manual mode.
- 4.2.6 Position appropriate MAIN/COAX switch MAIN.
- 4.2.7 Turn WEAPON POWER circuit breaker ON.
- 4.2.8 Verify WEAPON PWR indicator lit.
- 4.2.9 Position WPN ARM switch to ARM.
- 4.2.10 Verify appropriate LOW AMMO indicator not lit.

- 4.2.11 Verify MAIN gun indicator lit.
- 4.2.12 Verify SEAR indicator lit.
- 4.2.13 Position AP/HE switch as appropriate.
- 4.2.14 Verify appropriate AP/HE indicator lit.
- 4.2.15 Position 200/100/SS switch as appropriate.
- 4.2.16 Verify appropriate 200/100/SS indicator lit.

NOTE

Weapon ready to fire from auxiliary trigger.

- 4.3 PERFORM M240 COAX PRE-FIRE CHECKLIST PROCEDURES (POWERED DRIVE).
 - 4.3.1 Verify appropriate vehicle hatches closed and locked.
 - 4.3.2 Turn AUXILIARY POWER circuit breaker ON.
 - 4.3.3 Verify AUX PWR indicator lit.
 - 4.3.4 Position safety switch to F (Fire).
 - 4.3.5 Pull charging handle to rear.
 - 4.3.6 Position DRIVE SELECT lever up for power mode.
 - 4.3.7 Turn TURRET POWER circuit breaker ON.
 - 4.3.8 Verify TURRET PWR indicator lit.
 - 4.3.9 Position MAIN/COAX switch to COAX.
 - 4.3.10 Turn WEAPON POWER circuit breaker ON.
 - 4.3.11 Verify WEAPON PWR indicator lit.
 - 4.3.12 Set WEAPON ARM switch to ARM.
 - 4.3.13 Verify COAX LOW AMMO indicator not lit.
 - 4.3.14 Verify COAX indicator lit.

NOTE

Weapon ready to fire from hand control.

- 4.4 PERFORM M240 COAX PRE-FIRE CHECKLIST PROCEDURES (MANUAL DRIVE).
 - 4.4.1 Verify appropriate vehicle hatches closed and locked.
 - 4.4.2 Turn AUXILIARY POWER circuit breaker ON.
 - 4.4.3 Verify AUX PWR indicator lit.
 - 4.4.4 Position safety switch to F (Fire).
 - 4.4.5 Pull charging handle to rear.

AD-A138 424

LIGHT ARMORED VEHICLE (LAV) TRAINING EQUIPMENT SURVEY
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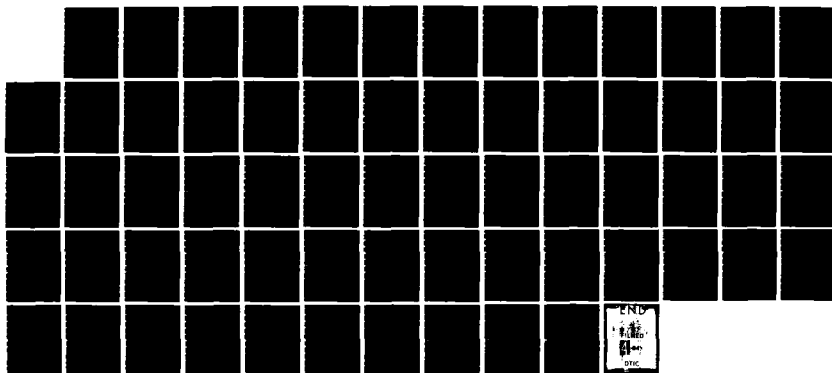
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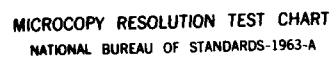
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

- 4.4.6 Position DRIVE SELECT lever down for manual mode.
- 4.4.7 Position MAIN/COAX switch to COAX.
- 4.4.8 Verify COAX indicator lit.
- 4.4.9 Turn WEAPON POWER circuit breaker ON.
- 4.4.10 Verify WEAPON PWR indicator lit.
- 4.4.11 Set WEAPON ARM switch to ARM.
- 4.4.12 Verify COAX LOW AMMO indicator not lit.

NOTE

Weapon ready to fire from auxiliary trigger.

4.5 PERFORM STAB OPERATING PROCEDURE.

NOTE

STAB operation is effective only when vehicle is mobile.

- 4.5.1 Perform TURRET POWER-UP procedure.
- 4.5.2 Turn STAB switch ON.
- 4.5.3 Verify STAB ON indicator lit.
- 4.5.4 Verify STAB AZ and EL indicators not lit.
- 4.5.5 Perform M36E1 DAYSIGHT and/or NIGHTSIGHT operating procedures.
- 4.5.6 Close palm switch (keep hand control in neutral).
- 4.5.7 Check for drifting LOS.

NOTE

If LOS drifts more than 5 mils in 15 sec in azimuth or elevation perform LOS DRIFT COMPENSATION procedure.

4.6 PERFORM M36E1 DAYSIGHT OPERATING PROCEDURE.

- 4.6.1 Adjust seat height for use of daysight.

WARNING

Do not aim sight at sun. Serious eye damage may occur.

CAUTION

The nightsight will be damaged if exposed to daylight with the nightsight power switch ON. Before using the M36E1 sight during daylight, make sure nightsight power switch is in OFF position.

- 4.6.2 Open M119 sight shield by turning sight shield handle clockwise (15°) and pushing up.
- 4.6.3 Adjust brow pad for proper eye relief.
- 4.6.4 Sight a distant object through daysight and adjust diopter ring for sharp focus.
- 4.6.5 Record diopter setting.
- 4.6.6 Turn AUXILIARY POWER circuit breaker ON.
- 4.6.7 Verify that AUX PWR indicator lit.
- 4.6.8 Adjust reticle brightness for personal comfort.

4.7 PERFORM LOS DRIFT COMPENSATION PROCEDURE.

NOTE

The LOS drift compensation procedure can be used anytime the turret is powered-up to keep the LOS from drifting. If STAB operation is not desired, omit steps 4.7.2 and 4.7.3.

- 4.7.1 Perform TURRET POWER-UP procedure.
- 4.7.2 Turn STAB switch ON.
- 4.7.3 Verify STAB ON indicator lit.
- 4.7.4 Verify that STAB AZ and EL indicators not lit..
- 4.7.5 Close palm switch (keep hand control in neutral).

- 4.7.6 If LOS drifts more than 5 mile in 15 sec., adjust STAB AZ and/or EL DRIFT knobs as required until LOS azimuth drift is less than 5 mile in 15 sec.

4.8 PERFORM M36E1 NIGHTSIGHT OPERATING PROCEDURE.

- 4.8.1 Loosen front and rear latches securing nightsight elbow to M36E1 sight assembly and remove elbow from sight assembly.
- 4.8.2 Remove and store rubber cover from nightsight elbow.
- 4.8.3 Position nightsight elbow on M36E1 sight assembly and secure with front and rear latches.
- 4.8.4 Turn AUXILIARY POWER circuit breaker ON.
- 4.8.5 Verify AUX PWR indicator lit.

CAUTION

Do not turn nightsight power switch ON during daylight. Exposure to bright light can damage image intensifier tube.

- 4.8.6 Turn nightsight elbow power switch (on right side of elbow) ON.
- 4.8.7 Adjust seat height for use of nightsight.
- 4.8.8 Adjust brow pad for personal comfort.
- 4.8.9 Sight through nightsight eyepiece and adjust diopter ring for sharp focus on nightsight screen.
- 4.8.10 Record diopter setting.
- 4.8.11 Open M119 sight shield by turning sight shield handle clockwise (15°) and pushing up.
- 4.8.12 Adjust focus ring as necessary for sharp focus on a distant object.
- 4.8.13 Adjust RETICLE BRIGHTNESS for personal comfort.

NOTE

Always turn off RETICLE BRIGHTNESS when not in use.

CAUTION

**At end of mission and before full daylight,
perform the following steps.**

- 4.8.14 Turn nightsight power switch OFF.**
- 4.8.15 Loosen front and rear latches securing nightsight elbow to
M36E1 sight assembly and remove elbow from sight assembly.**
- 4.8.16 Install rubber cover on nightsight elbow.**
- 4.8.17 Position nightsight elbow on sight assembly and secure
with front and rear latches.**

5. PERFORM TARGET ACQUISITION

5.1 SELECT/OCCUPY OBSERVATION POSITIONS.

5.1.1 When moving use turret-down or hull-down routes.

5.1.2 When stationary use:

5.1.2.1 Cover/concealed turret down positions with
dismounted observer.

5.1.2.2 Cover/concealed hull-down positions.

5.2 ASSIGN TARGET AREA RESPONSIBILITIES.

5.2.1 VC: look for likely targets within assigned sector of
responsibility.

5.2.2 Gunner: look for likely targets within assigned sector of
responsibility.

5.3 SCAN FOR TARGETS.

5.3.1 Without optics make quick overall search for obvious
targets.

5.3.2 With optics make detailed search of terrain using 50 meter
method.

5.3.2.1 Search a strip 50 meters deep from right to
left.

5.3.2.2 Then search from left to right farther out
overlapping the first strip.

5.3.2.3 Continue until entire section is covered.

5.3.2.4 When a suspicious spot is detected, stop and
search it thoroughly.

5.3.3 Search from far to near when suspecting air threat.

5.4 PERFORM NIGHT ACQUISITION.

5.4.1 Scan with off-center vision with short, abrupt, irregular
eye movements. Pause a few seconds to detect any motion
at each likely target.

5.4.2 Listen for sounds and smell for odors.

5.4.3 Use night vision devices (passive).

5.5 SCAN FOR TARGET IDENTIFICATION.

5.5.1 Identify target as friend or foe.

5.5.2 Rank threat as:

5.5.2.1 Most dangerous.

5.5.2.2 Dangerous.

5.5.2.3 Least dangerous.

5.5.3 Acquisition reports:

5.5.3.1 Who is reporting?

5.5.3.2 Target description.

5.5.3.3 Where the target is.

5.5.3.4 What the target is doing.

NOTE

If time permits, proceed with 5.5.4.

5.5.4 SALUTE

5.5.4.1 Size.

5.5.4.2 Activity.

5.5.4.3 Location.

5.5.4.4 Unit.

5.5.4.5 Time.

5.5.4.6 Equipment.

6. EMPLOY WEAPON SYSTEM

6.1 ISSUE INITIAL FIRE COMMAND.

- 6.1.1 Commander announces the Alert.
- 6.1.2 Commander announces the type of Ammunition and rate of fire.
- 6.1.3 Commander announces target description.
- 6.1.4 Commander announces the direction in which to slew the turret. (This step may be omitted.)
- 6.1.5 Commander announces the approximate range of the target. (This step may be omitted.)
 - 6.1.5.1 Commander slews turret in direction indicated.
 - 6.1.5.2 Gunner announces "IDENTIFIED" when he sees the TARGET. (This step will occur the instant the gunner sees the target.)

NOTE

Once Gunner announces "IDENTIFIED," Commander releases the override of the gun, and turns control of the gun to the gunner. Once Gunner has control of the gun he makes a precision lay of the gun.

- 6.1.6 Commander announces "FIRE."
- 6.1.7 Commander announces "ON THE WAY."
- 6.1.8 Gunner announces "CEASE FIRE."

6.2 PERFORM PRECISION FIRING SEQUENCE.

- 6.2.1 Acquire target within the sight's field of view.
- 6.2.2 Determine range utilizing stadia reticle or the most accurate means available.
- 6.2.3 Determine the type of ammunition. Range numbers on the left side of reticle are used for HE and TP ammunition. AP range is identified on the right side of reticle.

- 6.2.4 Determine the sighting point on the reticle. Select the point on the range line that corresponds to the range determined in step 2 and the type of ammunition selected in step 3.
- 6.2.5 Determine cross range velocity. Cross range velocity is defined as movement of the target or vehicle perpendicular to the line of fire. If cross range velocity is zero, the gun is now aimed. If it is not zero, then a lead angle must be developed.
- 6.2.6 Determine lead angle direction. Using your vehicle as reference, determine whether the target vehicle is moving to your right or left. Move the sighting point in the direction of target movement.
- 6.2.7 Determine lead angle. Using the estimated cross range velocity, apply lead angle as appropriate from the lead angle table.

LEAD ANGLE TABLE		
CROSS RANGE VELOCITY	LEAD ANGLE IN MILLS	
Miles Per Hours	AP	HE
5 MPH	2	3
15 MPH	05	08
30 MPH	11	16
50 MPH	18	27

- 6.2.8 Determine the sighting point on the reticle. Move the sighting point (step 4) in the lead angle direction (step 6) by the amount of mils in the lead angle (step 7).
- 6.2.9 FIRE on command.

6.3 APPLY BATTLESIGHT FIRING TECHNIQUE.

- 6.3.1 Prepare for battlesight firing technique
- 6.3.1.1 Determine the most likely targets to be engaged.
- 6.3.1.2 Determine the type of ammunition to be fired.
- 6.3.1.3 Select the designated ammunition.

- 6.3.1.4 Cycle the M242 Main Gun in order to load the gun.
- 6.3.1.5 Set M242 Main gun safety to FIRE (inline).
- 6.3.1.6 Set WPN ARM switch to SAFE.
- 6.3.2 Acquire the target
- 6.3.3 Using choke reticle, determine appropriate range for ammunition selected.
- 6.3.4 Determine that target is in Battlesight range.
- 6.3.5 Issue fire command.
 - 6.3.5.1 Commander announces "GUNNER," and slews turret in direction of target.
 - 6.3.5.2 Commander announces "BATTLESIGHT."
 - 6.3.5.3 Gunner sets WPN ARM switch to ARM
 - 6.3.5.4 Commander announces the description of target (e.g., BMP, Troop, Tank).
 - 6.3.5.5 Gunner announces "IDENTIFIED."
 - 6.3.5.6 Commander releases hand control.
 - 6.3.5.7 Commander announces "FIRE."
 - 6.3.5.8 Gunner makes final lay of gun, announces "ON THE WAY," and FIRES.
 - 6.3.5.9 Commander announces "CEASE FIRE."
- 6.4 PERFORM SENSING AND BURST ON TARGET ADJUSTMENT.
 - 6.4.1 Gunner calls out range sensings: short, over, target, doubtful or lost (gunner).
 - 6.4.2 Employ burst on target for direct fire adjustment:
 - 6.4.2.1 Fire 3 to 5 round burst.
 - 6.4.2.2 Adjust center of impact to center of mass of target.
 - 6.4.2.3 For moving targets using BOT, track continuously before, during and after firing (gunner)

NOTE

If burst on target not possible, Commander issues subsequent fire command.

6.4.3 Issue subsequent fire command, if necessary (Vehicle Commander)

- 6.4.3.1 Alert (SHORT, OVER, ON TARGET, LOST, DOUBTFUL)**
- 6.4.3.2 Deflection correction (When given, it is LEFT or RIGHT by specified number of mils).**
- 6.4.3.3 Range correction (Add or drop by number of meters)**
- 6.4.3.4 Execution (FIRE)**
- 6.4.3.5 Corrections (Repeat 6.4.3.1 through 6.4.3.4)**
- 6.4.3.6 Target (Describe target)**
- 6.4.3.7 Cease fire**

6.5 ENGAGE TARGETS WITH M242 MAIN GUN CANNON.

- 6.5.1 Estimate range to target.**
- 6.5.2 Estimate speed of moving target.**
- 6.5.3 Move controls to correct aim point.**
- 6.5.4 Fire M242 at stationary target from stationary vehicles.**
- 6.5.5 Fire M242 at stationary target from moving vehicle.**
- 6.5.6 Fire M242 at moving target from stationary vehicle.**
- 6.5.7 Fire M242 at moving target from moving vehicle.**
- 6.5.8 Adjust rounds to target using burst-on-target (BOT) method.**

6.6 ENGAGE TARGETS WITH M240 COAX MACHINE GUN.

- 6.6.1 Estimate range to target.**
- 6.6.2 Estimate speed of moving target.**
- 6.6.3 Move controls to correct aim point.**
- 6.6.4 Fire M240 at stationary target from stationary vehicle.**
- 6.6.5 Fire M240 at stationary target from moving vehicle.**
- 6.6.6 Fire M240 at moving target from stationary vehicle.**
- 6.6.7 Fire M240 at moving target from moving vehicle.**

6.7 EMPLOY M257 GRENADE LAUNCHER.

WARNING

Crew should be in vehicle and all hatches closed when firing grenade launcher.

- 6.7.1 Turn WEAPON POWER circuit breaker ON.
 - 6.7.2 Verify WEAPON PWR indicator lit.
 - 6.7.3 Turn either or both salvo switches on.
 - 6.7.4 Verify GRENADE LAUNCHER READY INDICATOR lit.
 - 6.7.5 Lift fire switch guard and push up on fire toggle switch.
 - 6.7.6 Turn either or both salvo switches off.
 - 6.7.7 Verify that ready indicator not lit.
- 6.8 SELECT AND OCCUPY FIRING POSITIONS.
- 6.8.1 Primary Position - Position LAV to cover most likely enemy avenues of approach.
 - 6.8.2 Alternate Position - Position LAV to cover same target areas as primary position.
 - 6.8.3 Supplementary Position - Position LAV to cover target areas or enemy routes of advance that cannot be covered from primary or alternate positions (usually flanks or rear).
 - 6.8.4 Use turret-down positions when observing and acquiring targets.
 - 6.8.5 Use hull-down positions for all direct fire gun engagements.
 - 6.8.6 Turret-down to hull-down:
 - 6.8.6.1 Move LAV forward slowly (driver).
 - 6.8.6.2 Level the gun and look through optical sight (gunner).
 - 6.8.6.3 Stop LAV where target can be seen without obstruction.
 - 6.8.7 Defensive operations:
 - 6.8.7.1 Select covered and concealed positions below the topographical crest and preferably on the sides of a hill to avoid skylining.

- 6.8.7.2 Avoid swampy areas and hillsides, select positions which are dry and level.
- 6.8.7.3 Select covered and concealed routes into and out of the position.
- 6.8.7.4 Avoid selecting positions near or within prominent terrain features.
- 6.8.7.5 Avoid unnecessary movement and heat and light generation while in positions.
- 6.8.7.6 Camouflage is continuous.

7. PERFORM IMMEDIATE ACTION PROCEDURES

7.1 STOP RUNAWAY TURRET.

- 7.1.1 Turn TURRET POWER circuit breaker OFF. If Turret does not stop go to Step 7.1.2.**
- 7.1.2 Position DRIVE SELECT lever down for manual mode. If Turret does not stop go to Step 7.1.3.**
- 7.1.3 Turn VEHICLE MASTER SWITCH to OFF.**
- 7.1.4 Turn TURRET DRIVE LOCK to LOCK.**

7.2 REDUCE M242 MAIN GUN FAILURE TO FIRE.

- 7.2.1 Verify that M242 safety is in FIRE position (inline).**
- 7.2.2 Verify bolt position indicator in SEAR.**
- 7.2.3 Verify level of ammunition.**
- 7.2.4 If ammunition is exhausted perform ammo uploading procedure.**
- 7.2.5 If ammunition is present check**
 - 7.2.5.1 Check to see if ammo is binding in box.**
 - 7.2.5.2 Check that feed chutes are latched in place at main gun feeder and at ammo box.**
 - 7.2.5.3 Check that feed chutes have no binding ammo, broken ammo belt, or separated ammo belt.**
 - 7.2.5.4 Check that ammo links are not binding in link ejection chutes. If links are binding, notify organizational maintenance.**
- 7.2.6 Attempt to fire weapon. If weapon fires continue mission. If weapon fails to fire, go to 7.2.7.**
- 7.2.7 Ensure lead round is in feed sprocket.**
 - 7.2.7.1 With 14 mm ratchet wrench, turn ammo forwarder 1/4 turn to forward ammo.**

NOTE

To forward AP ammo, turn AP forwarder clockwise.
To forward HE ammo, turn HE forwarder counter-clockwise.

- 7.2.8 If bolt position indicator is not in SEAR and it is before DWELL, place a No. 4 cross point screwdriver on the drive shaft and turn handle clockwise to move bolt position indicator back to SEAR.
- 7.2.9 If bolt position indicator is not in SEAR and is after DWELL, place a No. 4 crosspoint screwdriver on drive shaft and turn drive shaft counterclockwise to move bolt position indicator forward to SEAR.
- 7.2.10 Fire main gun. If main gun fires, end troubleshooting. If main gun fails to fire, notify organizational maintenance.

7.3 PERFORM M242 MAIN GUN MISFIRE PROCEDURE (COOL GUN).

NOTE

Main gun is considered cool if less than 50 rounds have been fired in last five minutes.

WARNING

Accidental firing of main gun could result in death or injury. Ensure that main gun is aimed in a safe direction and that no personnel or equipment are in line of fire.

- 7.3.1 If first round, ensure M242 safety is in FIRE (inline).
- 7.3.2 Wait five seconds. Press misfire reset warning indicator.
- 7.3.3 Close palm switch and squeeze trigger on gunner's hand control. Gun should fire. If not go to 7.3.4.
- 7.3.4 Set WEAPON ARM switch to SAFE.
- 7.3.5 Place M242 safety to SAFE (crosswise).
- 7.3.6 Set WEAPON ARM switch to ARM.
- 7.3.7 Press MISFIRE RESET WARNING INDICATOR.
- 7.3.8 Position Gunner's 200/100/SS switch to SS.
- 7.3.9 Place M242 safety to FIRE (inline).

- 7.3.10 Close palm switch and squeeze trigger on Gunner's Hand Control.

NOTE

Bolt position indicator on main gun should cycle to SEAR and SEAR indicator on CDU should light. If conditions are obtained, proceed to step 7.3.13. If conditions are not obtained, perform steps 7.3.11 or 7.3.12 as required.

- 7.3.11 If bolt position indicator has not cycled out of the MISFIRE position, proceed to IMMEDIATE ACTION TO CLEAR JAMMED MAIN GUN procedure.
- 7.3.12 If bolt position is at SEAR but SEAR indicator on CDU is not lit, press LAMP TEST switch up to ON.. If SEAR indicator lights, go to 7.3.13.

NOTE

If SEAR indicator does not light, replace bulb at first opportunity.

- 7.3.13 Close palm switch and squeeze trigger on Gunner's Hand Control.
- 7.3.13.1 If main gun fires, gun is operational. Go to 7.3.14.
- 7.3.13.2 If bolt position indicator cycles to MISFIRE, troubleshoot malfunction.
- 7.3.14 Reset Gunner's 200/100/SS switch to desired setting and continue mission.

- 7.4 PERFORM M242 MAIN GUN MISFIRE PROCEDURE (HOT GUN).
Main gun is considered hot if more than 100 rounds have been fired in last fifteen minutes.

WARNING

Accidental firing of main gun could result in death or injury. Ensure that main gun is aimed in a safe direction and that no personnel or equipment are in line of fire.

- 7.4.1 Set WEAPON ARM switch to SAFE.
- 7.4.2 Place M242 safety to SAFE (crosswise).
- 7.4.3 Set WEAPON ARM switch to ARM.
- 7.4.4 Position Gunner's 200/100/SS switch to SS.
- 7.4.5 Set main gun manual safety to FIRE (inline).
- 7.4.6 Close palm switch and squeeze trigger on Gunner's Hand Control.

NOTE

Bolt position indicator on main gun should cycle to SEAR and SEAR indicator on CDU should light. If conditions are obtained, proceed to step 7.4.9. If conditions are not obtained, perform steps 7.4.7 or 7.4.8 as required.

- 7.4.7 If bolt position indicator has not cycled out of MISFIRE, WARN ALL PERSONNEL OF A COOKOFF DANGER. All personnel shall remain clear of gun barrel for thirty minutes or until round cooks off, whichever occurs first. Proceed then to step 7.4.10.
- 7.4.8 If bolt position indicator cycles to MISFIRE, troubleshoot.
- 7.4.9 Close palm switch and squeeze trigger on Gunner's Hand Control.
 - 7.4.9.1 If main gun fires, gun is operational. Go to 7.4.11.
 - 7.4.9.2 If bolt position indicator cycles to MISFIRE, troubleshoot.
- 7.4.10 Cycle main gun to SEAR position as follows:
 - 7.4.10.1 Open weapons enclosure bag.

- 7.4.10.2 Turn locking ring on power cable left and unplug cable.
- 7.4.10.3 Place M242 safety to SAFE (crosswise).
- 7.4.10.4 Insert handcrank into manual drive gear hub.

NOTE

Main gun cannot be cycled to SEAR position if it is jammed. If gun cannot be cycled to SEAR position, proceed to IMMEDIATE ACTION TO CLEAR JAMMED MAIN GUN procedure.

- 7.4.10.5 Press in and hold sear release link lever.
- 7.4.10.6 Turn handcrank counterclockwise. Let go of sear release link lever when bolt position indicator clears MISFIRE position.
- 7.4.10.7 When bolt position indicator reaches SEAR position, stop turning handcrank and remove it from manual drive gear hub.
- 7.4.10.8 Connect power cable to M242 and turn locking ring to the right to lock.
- 7.4.11 Place M242 safety to FIRE (in line).
- 7.4.12 Position Gunner's 200/100/SS switch to desired setting and continue mission.
- 7.4.13 Troubleshoot cause of misfire at earliest opportunity.

7.5 PERFORM SAFETY PROCEDURES WHEN HOT M242 MAIN GUN FAILS TO FIRE AND BOLT POSITION INDICATOR IN POSITION OTHER THAN SEAR AND MISFIRE.

WARNING

Main gun is considered hot if more than 100 rounds have been fired in the past 15 minutes or 50 rounds in the past 5 minutes.

- 7.5.1 Notify all persons aboard of cookoff danger.
- 7.5.2 Notify driver to stop vehicle and set master switch to OFF.

- 7.5.3 All personnel except Commander exit vehicle immediately
- 7.5.4 Commander aim gun downrange.
- 7.5.5 Turn TURRET POWER, WEAPON POWER and AUXILIARY POWER circuit breakers to OFF.
- 7.5.6 Set Turret Drive Lock to LOCK. Exit vehicle.
- 7.5.7 Remain clear of vehicle for 30 minutes or until cookoff.
- 7.5.8 After 30 minutes or cookoff troubleshoot main gun.

7.6 PERFORM IMMEDIATE ACTION TO CLEAR JAMMED MAIN M242 GUN.

WARNING

Accidental firing of M242 could result in death or injury. Ensure that M242 is aimed in a safe direction and that no personnel or equipment is in line of fire.

- 7.6.1 Tell driver to stop vehicle.
- 7.6.2 Turn TURRET POWER and WEAPON POWER circuit breakers OFF.
- 7.6.3 Turn TURRET DRIVE LOCK to LOCK.
- 7.6.4 Set WPN ARM switch to SAFE.
- 7.6.5 Place M242 safety to SAFE (crosswise).
- 7.6.6 Turn locking ring on power cable to left and disconnect power cable.
- 7.6.7 Use manual elevation handcrank to raise gun to between 15° and 30° elevation.
- 7.6.8 Disconnect link chutes from main gun feeder as follows:
 - 7.6.8.1 Release latch on link chute and move chute away from feeder.
 - 7.6.8.2 Disconnect links in link chute from link coming out of feeder.
 - 7.6.8.3 Move link chute out of way so feeder can be removed.
- 7.6.9 Disconnect feed chutes from feeder.
- 7.6.10 Break ammo belts at feeder.
- 7.6.11 Press button in center of drive shaft knob and pull drive shaft knob down approximately three inches.

- 7.6.12 Press and hold feeder handle lock.
- 7.6.13 Rotate feeder handle up (away from gun).
- 7.6.14 Release feeder handle lock.
- 7.6.15 Slide feeder from main gun. If feeder will not slide out, locate jam and remove it. If jam cannot be safely removed, notify organizational maintenance.
- 7.6.16 Place main gun feeder on floor.
- 7.6.17 Remove jammed AP and HE rounds and links from main gun feeder as follows:
 - 7.6.17.1 Press feed select solenoid knob in.
 - 7.6.17.2 Press in and hold timer lift rod in center of worm nut shaft.
 - 7.6.17.3 Turn worm nut shaft counter clockwise and release timer lift rod. Continue turning worm nut shaft counterclockwise until timer lift rod pops back out.
 - 7.6.17.4 Repeat substeps 7.6.17.2 through 7.6.17.3 until feeder is cleared of AP ammo.
 - 7.6.17.5 Pull feed select solenoid knob out.
 - 7.6.17.6 Repeat substeps 7.6.17.1 through 7.6.17.5 for HE ammo.
- 7.6.18 Inspect main gun feeder for damage. If feeder is not damaged, it may be reinstalled after receiver is cleared. If feeder is damaged, notify organizational maintenance.
- 7.6.19 Inspect receiver for jammed rounds. If there are no jammed rounds, proceed to step 7.6.23. If there are jammed rounds, proceed to step 7.6.20.
- 7.6.20 Remove jammed round from receiver assembly. If jammed round cannot be safely removed, notify organizational maintenance. If round is jammed in chamber and bolt is closed, proceed to step 7.6.21.
- 7.6.21 Unlock and retract bolt from chamber as follows:
 - 7.6.21.1 Place 12-inch adjustable wrench on square part of bolt shaft just behind bolt lugs.
 - 7.6.21.2 Press SEAR release solenoid.
 - 7.6.21.3 Turn bolt clockwise with wrench to unlock.

- 7.6.21.4 Turn drive shaft, on bottom of receiver, counterclockwise to retract bolt from chamber. If bolt will not retract, notify organizational maintenance.
 - 7.6.22 Remove jammed round from receiver. If jammed round cannot be safely removed from receiver, notify organizational maintenance.
 - 7.6.23 Inspect receiver for damage. If receiver is undamaged, reinstall feeder per main gun feeder installation procedure. If receiver is damaged, notify organizational maintenance.
 - 7.6.24 Reload main gun per HE and AP FEED SYSTEM LOADING procedures.
- 7.7 STOP RUNAWAY M240 COAX.

WARNING

Runaway COAX can cause death or injury.
Keep COAX pointed in a safe direction.

- 7.7.1 Set WEAPON ARM switch to SAFE. If COAX continues to fire, go to 7.7.2.
- 7.7.2 Point COAX in safe direction.
- 7.7.3 Tell driver to stop vehicle.
- 7.7.4 Turn TURRET POWER circuit breaker OFF.
- 7.7.5 Verify TURRET PWR indicator light OFF
- 7.7.6 Turn WEAPON POWER circuit breaker OFF.
- 7.7.7 Verify WEAPON PWR indicator OFF.
- 7.7.8 If COAX still fires after power OFF:
 - 7.7.8.1 Grab COAX charger handle, pull back and hold or
 - 7.7.8.2 Grab COAX ammo belt at ammo box, twist and hold or
 - 7.7.8.3 If near end of ammo belt let COAX fire until end of ammo.
- 7.7.9 Perform immediate action to clear COAX.
- 7.7.10 Unload COAX and notify organizational maintenance.

7.8 REDUCE COAX GUN FAILURE TO FIRE (HOT GUN).

WARNING

When COAX is hot, COOKOFF of live round can kill or injure. If immediate action cannot be completed within 1 minute exit turret for 30 minutes. COAX is considered HOT when 300 rounds have been fired in 3 minutes or less.

- 7.8.1 Set WEAPON ARM switch to safe.
- 7.8.2 Position COAX manual safety to S (safe).
- 7.8.3 Pull back firmly on charger handle to eject misfired shell and charge COAX.
If COAX is hot and bolt does not lock in rear position, go to Step 7.8.5.
- 7.8.4 If misfired round is ejected and COAX gun charges, set manual safety to F (FIRE), set WEAPON ARM switch to ARM, and continue firing.
- 7.8.5 Notify all personnel aboard vehicle of COOKOFF danger.
- 7.8.6 Commander aim gun downrange.
- 7.8.7 Notify driver to stop vehicle and set vehicle master switch to OFF.
- 7.8.8 All personnel except commander exit vehicle immediately.
- 7.8.9 Commander sets TURRET POWER, WEAPON POWER, AUXILIARY POWER circuit breakers to OFF.
- 7.8.10 Set TURRET DRIVE LOCK to LOCK and exit vehicle.
- 7.8.11 After 30 minutes return to vehicle and perform COAX clearing procedure.

7.9 PERFORM M240 COAX MISFIRE PROCEDURE.

WARNING

COAX is considered hot if more than 100 rounds have been fired in two minutes. If COAX is hot, do not perform any of the following steps, but go to COAX FAILS TO FIRE (HOT GUN) Procedure.

- 7.9.1 Attempt to fire round by charging it and firing the COAX several times.
- 7.9.2 If COAX is still jammed, pull charger handle to rear to lock bolt back.
- 7.9.3 Place COAX manual safety to S (safe).
- 7.9.4 Push in latches and open cover assembly.
- 7.9.5 Remove ammo belt.
- 7.9.6 Raise feed tray.
- 7.9.7 Locate round in chamber.
- 7.9.8 Perform COAX removal procedure, remove jammed barrel and set aside.
- 7.9.9 Change barrel so COAX is ready to fire.
- 7.9.10 Perform COAX installation procedure.
- 7.9.11 Perform necessary COAX uploading procedure to reload COAX.
- 7.9.12 Place COAX manual safety to F (fire), and continue mission.
- 7.9.13 To remove stuck cartridge case from jammed barrel, perform following substeps:
 - 7.9.13.1 Lift case from chamber. Pry case rim with screwdriver if case is tight.
 - 7.9.13.2 If case cannot be pried loose, remove swab holder from cleaning rod, insert rod through muzzle of barrel and gently tap rod to dislodge case from barrel.
- 7.9.14 To remove ruptured cartridge case from jammed barrel, perform following substeps:
 - 7.9.14.1 Push ruptured cartridge extractor through ruptured case.
 - 7.9.14.2 Pull back on extractor handle to remove ruptured case from barrel.

- 7.9.15 To remove live round that was fed into a ruptured case from jammed barrel, perform following substeps:
 - 7.9.15.1 Perform substeps 7.9.12.1 and 7.9.12.2 to remove live round from ruptured case.
 - 7.9.15.2 Push ruptured cartridge case extractor through ruptured case.
 - 7.9.15.3 Pull back on extractor handle to remove ruptured case from barrel.
- 7.10 REDUCE M257 GRENADE LAUNCHER FAILURE TO LAUNCH.
 - 7.10.1 Stay clear of the launcher barrel for at least 30 minutes. Keep the launcher pointed downrange.
 - 7.10.2 After 30 minutes, follow the download procedure, store misfired grenade at safe distance from vehicle and notify organizational maintenance.
- 7.11 PERFORM EMERGENCY TURRET POWER-DOWN PROCEDURE.
 - 7.11.1 Turn TURRET POWER circuit breaker OFF.
 - 7.11.2 Turn WEAPON POWER circuit breaker OFF.
 - 7.11.3 Turn vehicle MASTER switch OFF.
- 7.12 PERFORM LOW AMMO OVERRIDE PROCEDURE.

NOTE

If firing of the Main Gun or COAX is required
and a LOW AMMO indicator is lit, perform 7.12.1.

- 7.12.1 To fire the selected low ammo, cycle the LOW AMMO OVERRIDE switch in the spring loaded ON position.

8. PERFORM POST-OPERATING PROCEDURES

8.1 PERFORM M242 MAIN GUN DOWNLOADING PROCEDURE.

- 8.1.1 Turn TURRET POWER circuit breaker OFF.
- 8.1.2 Verify TURRET PWR indicator not lit.
- 8.1.3 Turn TURRET DRIVE LOCK to LOCK.
- 8.1.4 Turn WEAPON POWER circuit breaker OFF.
- 8.1.5 Verify WEAPON PWR indicator not lit.
- 8.1.6 Place M242 manual safety to SAFE (crosswise).
- 8.1.7 Verify WPN ARM switch on SAFE.
- 8.1.8 If unloading AP, pull out feed select solenoid. If unloading HE, push in feed select solenoid.
- 8.1.9 Pull and hold the ready box forwarder release lever.
- 8.1.10 Pull mushroom (feed chute stop) to release the ammo belt.
 - 8.1.10.1 If feeder is jammed, it may be necessary to break the ammo belt at the feeder by releasing the feed chute and pulling one round out of the belt.
 - 8.1.10.2 Ammo belt will normally slide down the feedchute. However, if it doesn't, it can be cranked down using the 14mm ratchet wrench on the feed sprocket extension turning it in opposite direction of arrow..
 - 8.1.10.3 Stow 14 mm ratchet wrench.
 - 8.1.10.4 Repeat Steps 8.1.8 through 8.1.10.
- 8.1.11 Release forwarder release lever.
- 8.1.12 There is one round in the feeder, which can be fired downrange or removed by removing the feeder and cycling it manually.

8.2 PERFORM M240 COAX DOWNLOADING PROCEDURE.

- 8.2.1 Turn TURRET POWER circuit breaker OFF.
- 8.2.2 Verify TURRET PWR indicator not lit.
- 8.2.3 Turn TURRET DRIVE LOCK to LOCK.

WARNING

Downloading procedures requires working from inside of vehicle through turret opening. To prevent injury to personnel or damage to equipment, ensure that TURRET POWER circuit breaker remains in OFF position and TURRET DRIVE LOCK remains at LOCK position while working through turret opening.

- 8.2.4 Turn WEAPON POWER circuit breaker OFF.
 - 8.2.5 Verify WEAPON PWR indicator not lit.
 - 8.2.6 Turn WPN ARM switch to SAFE.
 - 8.2.7 Pull charging handle to rear to lock bolt back.
 - 8.2.8 Place COAX manual safety to S (safe).
 - 8.2.9 Push in latches and open cover assembly.
 - 8.2.10 Remove lead end of ammo belt from feed tray.
 - 8.2.11 Slide ammo belt back into feed chute.
 - 8.2.12 Raise feed tray.
 - 8.2.13 Look into chamber. If empty go to 8.2.14. If round in chamber perform COAX MISFIRE CLEARING procedure.
 - 8.2.14 Lower feed tray.
 - 8.2.15 Close cover.
 - 8.2.16 Place COAX manual safety to F (fire).
 - 8.2.17 Pull charging handle to rear, squeeze trigger, and ease bolt forward.
 - 8.2.18 Remove ammo belt from feed chute and 7.62 ammo box.
- 8.3 PERFORM M257 GRENADE LAUNCHER DOWNLOADING PROCEDURE.
- 8.3.1 Turn TURRET POWER circuit breaker OFF.
 - 8.3.2 Verify TURRET PWR indicator not lit.
 - 8.3.3 Turn TURRET DRIVE LOCK to LOCK position.
 - 8.3.4 Turn WEAPON POWER circuit breaker OFF.
 - 8.3.5 Verify WEAPON PWR indicator is not lit.
 - 8.3.6 Verify SALVO switches OFF.
 - 8.3.7 Use a grenade removing tool or a hooked wire to remove the grenades.

- 8.3.8 Store the grenades properly in grenade box.

WARNING

Do not place any part of hands or body
in front of launcher.

8.4 PERFORM TURRET POWER-DOWN PROCEDURE.

- 8.4.1 Turn WPN ARM switch to SAFE.
- 8.4.2 Turn WEAPON POWER circuit breaker OFF.
- 8.4.3 Verify WPN PWR indicator not lit.
- 8.4.4 Verify VENT switch OFF.
- 8.4.5 Position turret (guns forward at approximately +10° elevation).
- 8.4.6 Turn TURRET POWER circuit breaker OFF.
- 8.4.7 Verify TURRET PWR indicator not lit.
- 8.4.8 Turn TURRET DRIVE LOCK to LOCK.
- 8.4.9 Close Gunner's M36E1 sight shield.
- 8.4.10 Close Commander's M36E1 sight shield.
- 8.4.11 Turn intercom off.
- 8.4.12 Turn all radios off.
- 8.4.13 Verify Gunner's and Commander's nightsight RETICLE
Brightness Control OFF
- 8.4.14 Verify Gunner's and Commander's nightsight power switches
OFF
- 8.4.15 Turn AUXILIARY POWER circuit breaker OFF.
- 8.4.16 Verify AUX PWR indicator not lit
- 8.4.17 Turn vehicle MASTER switch off.
- 8.4.18 If required, close and lock Gunner's hatch.
- 8.4.19 If required, close and lock Commander's hatch.

8.5 PERFORM POST MISSION CHECKLIST PROCEDURE.

- 8.5.1 Turn TURRET DRIVE LOCK level to LOCKED position.
- 8.5.2 Check electrical harness for frayed wires and disconnected connectors.
- 8.5.3 Check hydraulic components for leaks.

- 8.5.4 Check hydraulic fluid reservoir level.
- 8.5.5 Check pop-up indicator on hydraulic fluid filter assembly. If up, notify organizational maintenance.
- 8.5.6 Check Commander's and Gunner's sights and vision blocks.
- 8.5.7 Verify Gunner's nightsight power switch OFF.
- 8.5.8 Verify Gunner's nightsight RETICLE Brightness control OFF.
- 8.5.9 Verify Commander's nightsight power switch OFF.
- 8.5.10 Verify Commander's nightsight RETICLE Brightness control OFF.
- 8.5.11 Check boresight/zeroing knobs for movement.
- 8.5.12 Check M242 Main gun and feed system.
 - 8.5.12.1 Main Gun manual safety to safe (crosswise).
 - 8.5.12.2 Main Gun in SEAR.
 - 8.5.12.3 Feed Chutes in place.
 - 8.5.12.4 Link Chutes in place and clear.
- 8.5.13 Verify A.P. ammo cover closed and latched.
- 8.5.14 Verify H.E. ammo cover closed and latched.
- 8.5.15 Check M240 COAX and Feed System.
 - 8.5.15.1 COAX manual safe on S (safe).
 - 8.5.15.2 Feed chute in place
 - 8.5.15.3 Link chute in place and clear
- 8.5.16 Radio and intercom systems OFF.
- 8.5.17 Perform M242 MAIN GUN preventive maintenance procedure.
- 8.5.18 Perform M240 COAX preventive maintenance procedure.
- 8.5.19 Perform M257 grenade launcher preventive maintenance procedure.
- 8.5.20 Perform optics and fire control equipment preventive maintenance.

8.6 MAINTAIN WEAPONS RECORD DATA/GUN BOOK ON M240/M242/M257
ITS - TBD

8.7 MAINTAIN VEHICLE LOGBOOKS
ITS - TBD

8.8 INITIATE VEHICLE WORK ORDERS
ITS - TBD

9. PERFORM PREVENTIVE MAINTENANCE

9.1 CLEAN, INSPECT, LUBRICATE M242 MAIN GUN.

- 9.1.1 Feeder Assembly - Clean, inspect and lubricate.**
 - 9.1.1.1 Perform feeder removal procedure.**
 - 9.1.1.2 Perform feeder disassembly procedure.**
 - 9.1.1.3 Wipe feeder with a clean rag dampened in LSA/CLP. Turn rotor to clean internal parts.**
 - 9.1.1.4 Wipe feeder with clean dry rag.**
 - 9.1.1.5 Rotate feeder handle to see if it locks and unlocks.**
 - 9.1.1.6 Push Feed Select Solenoid to AP position and turn Worm Nut Shaft until it locks into position.**
 - 9.1.1.7 Pull Feed Select Solenoid out to HE position and turn Worm Nut Shaft until it locks in position.**

NOTE

While turning Worm Nut Shaft, observe for movement of feed sprocket, rotor, and Bolt Position Indicator.

- 9.1.1.8 Lubricate Feeder Assembly.**

NOTE

DO NOT LUBRICATE Feed Select Solenoid, electrical connectors, cables or Bolt Position Indicator.

- 9.1.2 Receiver - Clean, inspect, lubricate.**
 - 9.1.2.1 Perform Track and Bolt Removal Procedure.**
 - 9.1.2.2 Clean heavy dirt from the receiver with soft brush.**
 - 9.1.2.3 Clear receiver with a clean rag dampened in LSA/CLP.**

NOTE

Keep LSA/CLP away from electrical connectors, Sear Solenoid cable and Drive Motor.

- 9.1.2.4 Wipe receiver with clean dry rag.**
- 9.1.2.5 Inspect receiver for cracked, broken or missing parts.**
- 9.1.2.6 Verify Drive Shaft Retaining Ring is in position.**
- 9.1.2.7 Inspect Locking Lugs for burrs visually and by running fingers over lugs.**
- 9.1.2.8 Inspect Track Latch Handle.**
- 9.1.2.9 Inspect electrical connector for corrosion, bent or broken pins.**
 - 9.1.2.9.1 Remove corrosion using dry bristle brush.**

CAUTION

Do not bend or break connector pins.

- 9.1.2.10 Inspect receiver for proper safety wiring.**
 - 9.1.2.11 Verify red ring on Reservoir Piston Rod is in view.**
 - 9.1.2.12 Verify Drive Motor securely attached.**
 - 9.1.2.13 Lubricate Rocker Assembly, Drive Shaft Splines, rear track, chain guides and Track Latch Hook with light coat of GMD.**
 - 9.1.2.14 Lubricate remainder of receiver with clean rag dampened in LSA/CLP.**
- 9.1.3 Track and Bolt Assembly. Clean, inspect, lubricate.**

WARNING

- o Solvent fumes can burn or poison.
- o Chain can move and injure fingers. Keep track assembly level, and keep fingers from between chain and sprockets.

- 9.1.3.1 Perform track and bolt disassembly procedure.
- 9.1.3.2 Using clean rag and cleaning solvent, clean bolt, bolt carrier, firing pin, firing pin sleeve, and track.
- 9.1.3.3 Check firing pin tip, spring, and firing pin tang. If any one of these is worn or broken, notify organizational maintenance.
- 9.1.3.4 Check track assembly for damage to chain drive sprockets, firing pin pawl, and safety pawl. If damage is found, notify organizational maintenance.
- 9.1.3.5 Check anvil for foreign objects. If object cannot be removed, notify organizational maintenance.

CAUTION

Grease on face of bolt causes dirt to collect in anvil which could cause main gun misfire.
Do not lubricate face of bolt.

- 9.1.3.6 Put GMD on clean rag and lightly grease flat surfaces at both sides of track rails.
- 9.1.3.6 Lightly grease outside of bolt carrier.
- 9.1.3.7 Using clean rag, remove excess grease from flat surfaces at both sides of track rails and from outside of bolt carrier.

CAUTION

When temperature is below -25° F (-32° C), GMD grease can cause track rails, slider, master link, and chain to stick. When temperature is below -25° F (-32° C), use LAW lubricating oil instead of GMD grease on track rails, slider, master link, and chain.

NOTE

If temperature is above -25° F (-32° C), do step 9.1.3.9. If temperature is below -25° F (-32° C) do step 9.1.3.10.

- 9.1.3.9 If temperature is above -25° F (-32° C), use brush to put light coat of GMD grease on firing pin, firing pin sleeve, bolt body, cross slot, carrier track, and firing pin pawl.
- 9.1.3.10 If temperature is below -25° F (-32° C), use brush to put light coat of LAW lubricating oil on firing pin, firing pin sleeve, bolt body, cross slot, track rails, slider, master link, chain, and safety link.

CAUTION

When temperature is below -25° F (-32° C), GMD grease can cause bolt lugs to stick. When temperature is below -25° F (-32° C), use LAW lubricating oil on bolt lugs instead of GMD grease.

NOTE

If temperature is above -25° F (-32° C), do step 9.1.3.11. If temperature is below -25° F (-32° C), do step 9.1.3.12.

9.1.3.11 If temperature is above -25° F (-32° C), use brush to apply a heavy coat of GMD grease to bolt lugs.

9.1.3.12 If temperature is below -25° F (-32° C), use brush to apply a heavy coat of LAW lubricating oil to bolt lugs.

9.1.4 Barrel - Clean, inspect, lubricate.

9.1.4.1 Use cleaning rod and swab with LSA/CLP to clean the barrel bore. Continue until the swabs come out clean.

9.1.4.2 Inspect barrel for loose muzzle brake.

9.1.4.3 Verify muzzle brake retaining pin in place.

9.1.4.4 Sight through barrel from chamber end and verify barrel not bent.

9.1.4.5 Verify barrel round count using weapon data book.

NOTE

If round count is above 13,000 rounds, notify organizational maintenance.

9.1.4.6 Visually inspect barrel bearings burrs and scars.

9.1.4.7 Use clean rags dampened with LSA/CLP and soft bristle brush to clean bearings.

9.1.4.8 Grease bearing with GMD using a brush.

9.1.4.9 Wipe down barrel with a light coat of LSA/CLP.

9.2 CLEAN, INSPECT, LUBRICATE M240 COAX

CAUTION

Do not use gasoline, kerosene, hydraulic oil, benzene, benzol, or high pressure water, steam, or air for cleaning the M240.

- 9.2.1 Perform M240 coax disassembly procedure.
- 9.2.2 Run a bore cleaning brush through bore to remove dirt or burned powder.
- 9.2.3 Run a swab soaked with LSA/CLP through bore until the bore is clean.
- 9.2.4 Use chamber brush, swabs, and LSA/CLP to clean gun chamber.
- 9.2.5 Check gas cylinder for carbon buildup. If gas cylinder has carbon buildup notify organizational maintenance.
- 9.2.6 Use swab and LSA/CLP with a receiver cleaning brush to remove powder fouling from the receiver.
- 9.2.7 Use clean, dry cloth to wipe buffer.
- 9.2.8 Move feed lever and cover labels to check spring tension.
- 9.2.9 Look for bent or worn parts.
- 9.2.10 Check flash suppressor for cracks, dents, tightness, burrs, and wear.
- 9.2.11 Check barrel adapter for cracks, dents, tightness, burrs, and wear.
- 9.2.12 Check barrel release lever for cracks, dents, tightness, burrs, and wear.
- 9.2.13 Pull charging handle to make sure charger assembly moves freely.
- 9.2.14 Look for bends, cracks, burred, or chipped rails.
- 9.2.15 Check for broken grips on trigger assembly.
- 9.2.16 Check assembly for bent cable guide on trigger assembly.
- 9.2.17 Check assembly for loose nut and bolt on trigger.
- 9.2.18 Check assembly for chipped or cracked trigger frame holding lug.
- 9.2.19 Check for loose or dirty solenoid.

- 9.2.20 Check trip lever and sear for damage, burns, cracks, chips, and wear.
- 9.2.21 Check cocking of the gun, move trip lever forward to see if sear lifted.
- 9.2.22 Position safety to S (safe).
- 9.2.23 Pull trigger, sear must not lower.
- 9.2.24 Position safety to F (fire).
- 9.2.25 Pull trigger, sear must lower.
- 9.2.26 Check operating rod, bolt, and drive spring for damage.
- 9.2.27 Press the roller to make sure it retracts.
- 9.2.28 Check electrical connectors for damage.
- 9.2.29 Check to be sure there are no bent prongs.
- 9.2.30 Lightly oil sliding parts by moving feed lever.
- 9.2.31 Lightly oil all rails.
- 9.2.32 Lightly oil the trip lever and sear surfaces.
- 9.2.33 Lightly oil roller post.
- 9.2.34 Lightly oil axis pins.
- 9.2.35 Lightly oil all polished parts of the piston extension.
- 9.2.36 Lightly oil primary extension ramps, feed roller surface, and driving spring.

NOTE

Do not oil top or face of bolt.

- 9.2.37 Wipe outside of barrel with lightly oiled rag and run a lightly oiled patch through the bore.
- 9.2.38 Perform M240 coax assembly procedure.
- 9.2.39 Perform M240 coax function check.

9.3 PERFORM M257 GRENADE LAUNCHER PM.

- 9.3.1 Perform turret power-down procedure.
- 9.3.2 Remove rubber caps from grenade launcher tubes (if launcher tubes are loaded with smoke grenades perform grenade downloading procedure).
- 9.3.3 Verify launcher tubes are free of dirt and trash.

- 9.3.4 Clear drain hole at bottom of each launcher tube with probe or small piece of wire.
- 9.3.5 Clean inside of grenade launcher tube using M242 main gun bore brush and LSA/CLP.

CAUTION

Do not use gasoline, kerosene, hydraulic oil, benzene, benzol, or high pressure water, steam, or air for cleaning the M257.

- 9.3.6 Dry grenade launcher tubes with clean rags.
- 9.3.7 Verify firing contacts are clean and not damaged.
- 9.3.8 Verify grenade launcher tubes are not bent or dented.
- 9.3.9 Verify grenade launcher tubes are secure on turret armor plate.
- 9.3.10 Install rubber caps on grenade launcher tubes.

9.4 PERFORM PM ON OPTICS.

- 9.4.1 Remove M27 periscopes.
- 9.4.2 Inspect periscopes for discoloration, interior moisture or cracks which could affect visibility. Report discrepancies to organizational maintenance.
- 9.4.3 Inspect periscope mount rubber seals for cracks, nicks, or dryness. Replace as necessary.
- 9.4.4 Replace M27 periscopes.
- 9.4.5 Remove M36E1 day/nightights (gunner's and commander's).
- 9.4.6 Inspect daysight and nightsight front lenses and rear lenses for dirt or moisture which could affect visibility. Report discrepancies to organizational maintenance.
- 9.4.7 Wipe interior of M119 sight mount with dry rag.
- 9.4.8 Install M36E1 day/nightight.
- 9.4.9 Inspect all control knobs and collars on the M36E1 for smooth movement.
- 9.4.10 Wipe clean all outside surfaces of the M36E1.

9.4.11 Operate sight shield operating handle checking for smooth operation.

9.4.12 Inspect sight shield housing spring for wear (stretching). Replace as necessary.

9.5 PERFORM PM ON WIRING HARNESES.

9.5.1 Check wiring harnesses for frayed wires and corroded, damaged, or disconnected connections. Report discrepancies to organizational maintenance.

9.6 PERFORM PM ON HYDRAULIC SYSTEM.

9.6.1 Check hydraulic fluid at sight gage. Gage should indicate full. Fill with MIL-H-46170 hydraulic fluid as necessary.

9.6.2 Check pop-up indicator on the hydraulic fluid filter assembly. If pop-up indicator is up, the filter should be replaced. Notify organizational maintenance.

9.6.3 Check hydraulic lines, connections and components for leaks. If leaks are found, notify organizational maintenance.

9.7 PERFORM PM ON FIRE CONTROL EQUIPMENT.

9.7.1 Position TURRET POWER circuit breaker to ON.

9.7.2 Hold the LAMP TEST switch in the ON position. All indicator lights should come on. Release switch.

9.7.3 Position Drive Select Lever UP (power mode).

9.7.4 Traverse and elevate using the gunner's and commander's hand controller checking for smooth operation.

9.7.5 Position TURRET POWER circuit breaker to OFF.

9.7.6 Position Drive Select Lever DOWN (manual mode).

9.7.7 Traverse and elevate using the elevation handcrank and the azimuth handwheel checking for smooth operation.

NOTE

Report discrepancies to organizational maintenance.

9.8 PERFORM PM ON DOMELIGHTS.

- 9.8.1 Turn domelights on and make sure they light in the white light, and in the blackout (blue/green light) modes.**
- 9.8.2 Wipe domelights with clean dry rag.**

9.9 PERFORM PM ON SEATS.

- 9.9.1 Inspect commander's and gunner's seats for rips, tears, holes, and open seams.**
- 9.9.2 Make sure seatbelts are securely fastened to the seats.**
- 9.9.3 Make sure seat adjustments work properly.**
- 9.9.4 Lightly oil seat post.**
- 9.9.5 Clean seat with stiff bristle brush.**

9.10 PERFORM PM ON TURRET CREW STATIONS.

- 9.10.1 Check for trash and loose items underneath turret platform and around turret crew stations.**
- 9.10.2 Make sure all controls and indicators are securely mounted.**

CAUTION

Do not use gasoline, kerosene, hydraulic oil, benzene, benzol, or high pressure water, steam or air for cleaning the M257.

9.11 PERFORM PM ON WEAPONS ENCLOSURE BAG.

- 9.11.1 Check weapons enclosure bag zippers for dirt and damage.**

NOTE

If weapon enclosure bag is torn, zippers do not move freely, notify organizational maintenance.

- 9.11.2 Wipe bag with clean damp rag.**

9.12 PERFORM PM ON M242 MAIN GUN AP AND HE FEED CHUTES.

- 9.12.1 Check main gun AP and HE feed chutes for damage.**

- 9.12.2 Check for bent or missing latches or latch pins on AP and HE feed chutes.

NOTE

If latches or latch pins are bent, and cannot be latched in place, notify organizational maintenance.

- 9.12.3 Wipe down AP and HE feed chutes with dry clean rag.

9.13 PERFORM PM ON M242 MAIN GUN AP AND HE LINK EJECTION CHUTES.

- 9.13.1 Visually check main gun AP and HE link ejection chutes for damage.
- 9.13.2 Visually check for bent or missing latches or latch pins on AP and HE link ejection chutes.

NOTE

If latches or latch pins are bent and cannot be latched in place, notify organizational maintenance.

- 9.13.3 Wipe down AP and HE link ejection chutes with dry clean rag.

9.14 PERFORM PM ON M240 COAX FEED CHUTE.

- 9.14.1 Check coax feed chute for damage.
- 9.14.2 Check for bent or missing latches or latch pins on coax feed chute.

NOTE

If latches or latch pins are broken or bent and feed chutes cannot be latched in place, notify organizational maintenance.

9.14.3 Wipe down feed chute with dry, clean rag.

9.15 PERFORM PM ON M240 COAX LINK EJECTION CHUTE.

9.15.1 Check coax link ejection chute for damage.

9.15.2 Check for bent or missing latches or latch pins on coax link chute.

NOTE

If latches or latch pins are broken or bent and link chute cannot be latched in place, notify organizational maintenance.

9.15.3 Wipe down link ejection chute with dry, clean rag.

10. PERFORM REMOVAL AND INSTALLATION PROCEDURES

10.1 PERFORM M242 MAIN GUN REMOVAL PROCEDURE.

10.1.1 Barrel

- 10.1.1.1 Traverse turret so that barrel is over front of vehicle.

WARNING

Traversing with power requires alarm "TRAVERSING."

- 10.1.1.2 Turn TURRET POWER circuit breaker switch OFF.
- 10.1.1.3 Turn WEAPON POWER circuit breaker switch OFF.
- 10.1.1.4 Verify indicators not lit.
- 10.1.1.5 Lock TURRET DRIVE LOCK to LOCK.
- 10.1.1.6 Place weapon manual safety on SAFE (crosswise).
- 10.1.1.7 Press and hold 25mm barrel latch in bottom of rotor extension.

WARNING

If barrel is hot, use asbestos gloves.

- 10.1.1.8 Rotate barrel counterclockwise 1/4 revolution until it reaches a hard stop.
- 10.1.1.9 Pull barrel out of receiver.

WARNING

Barrel weighs 89 pounds and will require two people to lift it.

10.1.2 Feeder

- 10.1.2.1 Position TURRET at 400 mils azimuth.

WARNING

Traversing with power requires alarm "TRAVERSING."

- 10.1.2.2 Turn TURRET POWER circuit breaker OFF.
- 10.1.2.3 Turn WEAPON POWER circuit breaker OFF.
- 10.1.2.4 Lock TURRET DRIVE LOCK to LOCK.
- 10.1.2.5 Unzip the weapons enclosure bag.
- 10.1.2.6 Place M242 manual safety on SAFE (crosswise).
- 10.1.2.7 Open Gunner's Sight Shield.
- 10.1.2.8 Disconnect AP and HE feed chutes from feeder.
- 10.1.2.9 Remove AP and HE link chutes.
- 10.1.2.10 Rotate drive shaft knob until bolt position indicator is in SEAR.
- 10.1.2.11 Press drive shaft button and pull drive shaft knob down approximately 3 inches.
- 10.1.2.12 Use manual elevation handcrank to position gun at approximately 15° elevation.
- 10.1.2.13 Press and rotate feeder handle up.

WARNING

Feeder may fall off receiver when feeder handle is rotated.

- 10.1.2.14 Slide feeder off receiver.

WARNING

Feeder weighs 54 pounds and may require two people to lift it.

- 10.1.2.15 Press DRIVE SHAFT Button in center of Drive Shaft knob, push Drive Shaft knob in as far as it will go, then release lock button.

10.1.3 Receiver.

- 10.1.3.1 Turn TURRET POWER and WEAPON POWER circuit breakers OFF.**
- 10.1.3.2 Position TURRET DRIVE LOCK to LOCK.**
- 10.1.3.3 Place M242 manual safety on SAFE (crosswise).**
- 10.1.3.4 Perform barrel removal procedure.**
- 10.1.3.5 Perform feeder removal procedure.**
- 10.1.3.6 Verify drive shaft locked in place.**
- 10.1.3.7 Disconnect electrical connector from receiver.**
- 10.1.3.8 Verify that gun is at approximately 15° elevation.**
- 10.1.3.9 Rotate red locking handle on gun mount towards center of turret.**
- 10.1.3.10 Rotate receiver counterclockwise approximately 35° and pull from gun mount.**

WARNING

Receiver weighs 92 pounds and will require two people to lift it.

10.1.4 TRACK AND BOLT ASSEMBLY REMOVAL.

- 10.1.4.1 Perform Feeder Removal Procedure.**
- 10.1.4.2 Push in drive shaft knob lock button and pull drive shaft handle down.**
- 10.1.4.3 Push up and hold sear release, and turn drive knob handle until bolt moves to rear of main gun receiver, then moves forward (approximately 1/2 inch from outside edge of chain) until sear assembly is between chain links.**
- 10.1.4.4 Move track latch handle to the straight out position.**
- 10.1.4.5 Using both hands, lift track and bolt assembly out of main gun receiver and place on smooth clean surface.**

WARNING

Chain can move in sprockets and cause injuries.
Use care when removing track and bolt assembly.

10.1.5 TRACK AND BOLT DISASSEMBLY.

WARNING

Chain can move and injure fingers in sprockets.
Do not lift assembly off work surface during
disassembly. Keep fingers clear of chain.

- 10.1.5.1 Turn forward left sprocket clockwise to move carrier to rear of track while pulling carrier back and up slowly.
- 10.1.5.2 Pull bolt carrier free when slider reaches either cross slot.
- 10.1.5.3 To unlock bolt from forward locking position, use cleaning rod to push firing pin tong toward rear of bolt carrier. Bolt should then move freely in bolt carrier.
- 10.1.5.4 Place bolt head on edge of work surface with ejector off of work surface.
- 10.1.5.5 Push down on firing pin sleeve.
- 10.1.5.6 Using fingertips, remove firing pin sleeve keeper.
- 10.1.5.7 Pull firing pin sleeve up and out of bolt.

CAUTION

Firing pin sleeve is small and can be lost.
Handle firing pin sleeve keeper with care.

- 10.1.5.8 Pull firing pin assembly out of bolt.
- 10.1.5.9 Turn bolt carrier over and remove cam pin.
- 10.1.5.10 Remove bolt from bolt carrier.

10.2 PERFORM M242 MAIN GUN INSTALLATION PROCEDURE.

10.2.1 TRACK AND BOLT ASSEMBLY.

- 10.2.1.1** Slide bolt into bolt carrier with cam pin hole facing up.
- 10.2.1.2** Align cam pin hole with cam pin slot, and push cam pin into cam pin hole until it is fully seated in bolt.
- 10.2.1.3** Place bolt head on work surface with ejector off work surface.
- 10.2.1.4** Slide firing pin into bolt with firing pin tang facing rear.
- 10.2.1.5** Install firing pin sleeve over firing pin and into bolt.
- 10.2.1.6** Clean firing pin sleeve keeper with clean rag.

CAUTION

Firing pin sleeve keeper is small and can be lost.
Handle firing pin sleeve key with care.

- 10.2.1.7** Insert and press firing pin sleeve keeper into hole in bolt.
- 10.2.1.8** Push down on rear of firing pin sleeve until firing pin sleeve keeper pops into hole.
- 10.2.1.9** Pull bolt all the way to forward position until firing pin tang locks.
- 10.2.1.10** Turn forward left sprocket until slider on chain master link is near rear right sprocket.

WARNING

Chain can move and injure fingers. Keep track assembly level, and keep fingers from between chain and sprockets.

- 10.2.1.11** Hold chain and forward left sprocket with left hand. Do not let chain move.

- 10.2.1.12 Place cross slot of bolt carrier over slider.
- 10.2.1.13 Twist bolt carrier toward rails. The bolt guide on bottom front of bolt should slip into track.

10.2.2 PERFORM MAIN GUN TRACK AND BOLT ASSEMBLY INSTALLATION.

NOTE

Track and bolt assembly installation procedure is the same whether the receiver is installed in gun mount or on work bench.

- 10.2.2.1 Push in drive shaft knob lock button and pull drive shaft handle down.
- 10.2.2.2 Push track latch handle to the out position.
- 10.2.2.3 Turn forward left sprocket counterclockwise until rear of bolt carrier is about 1/2 in. from outside edge of chain.

WARNING

Keep fingers from between sprocket and chain.
Chain can move and injure fingers.

- 10.2.2.4 Hold forward left sprocket so chain will not move, and place track and bolt assembly in main gun receiver.
- 10.2.2.5 If chain sear is not between chain links, turn drive shaft knob until chain sear is between chain links.
- 10.2.2.6 Push and wiggle track and bolt assembly until it is seated in main gun receiver.
- 10.2.2.7 Push track latch handle toward receiver as far as it will go.
- 10.2.2.8 Turn drive shaft knob until bolt moves to rear and locks in sear position.

10.2.2.9 Press lock button in center of drive shaft knob, and push drive shaft knob in as far as it will go, then release lock button.

10.2.3 RECEIVER.

10.2.3.1 Turn TURRET POWER and WEAPON POWER circuit breakers OFF.

10.2.3.2 Position TURRET DRIVE LOCK to LOCK.

10.2.3.3 Verify that gun mount is elevated approximately 15°.

10.2.3.4 Clean and lightly lubricate gun mount.

10.2.3.5 Rotate locking handle on gun mount towards center of turret.

10.2.3.6 Place HE (lower) link chute in position on gun mount.

10.2.3.7 Place weapon manual safety on SAFE (crosswise).

10.2.3.8 Rotate receiver so that buffer is on left.

WARNING

Receiver weighs 92 pounds and will require two people to lift it.

10.2.3.9 Insert receiver into gun mount.

10.2.3.10 Rotate receiver clockwise approximately 35°.

10.2.3.11 Rotate locking handle on gun mount away from center of turret.

10.2.3.12 Time the receiver (rotate drive shaft until the bolt is in SEAR position).

10.2.3.13 Connect electrical connector.

10.2.4 FEEDER.

10.2.4.1 Turn TURRET POWER circuit breaker OFF.

10.2.4.2 Turn WEAPON POWER circuit breaker OFF.

10.2.4.3 Position TURRET DRIVE LOCK to LOCK.

10.2.4.4 Open Gunner's Sight Shield.

10.2.4.5 Verify that gun mount is elevated approximately 15°.

- 10.2.4.6 Press receiver drive shaft button and pull drive shaft knob down approximately 3 inches.
- 10.2.4.7 Verify that the feeder has been timed.
- 10.2.4.8 Press and hold feeder handle lock.
- 10.2.4.9 Rotate feeder handle up and lock in place.
- 10.2.4.10 Line up feeder with receiver guide rails and slide feeder forward until feeder handle lines up with receiver.

WARNING

Feeder weighs 54 pounds and may require two people to lift it.

- 10.2.4.11 Press and hold feeder handle lock.
- 10.2.4.12 Rotate feeder handle down.
- 10.2.4.13 Release feeder handle lock.
- 10.2.4.14 Push receiver drive shaft knob up to receiver and lock in place.
- 10.2.4.15 Install HE and AP link chutes.
- 10.2.4.16 Disconnect feed chutes from ready box.
- 10.2.4.17 Place gun at 0° to 5° elevation.
- 10.2.4.18 Connect HE feed chute to gun.

NOTE

The AP feed chute is longer than the HE.

- 10.2.4.19 Connect AP feed chute to gun.
- 10.2.4.20 Connect HE and AP feed chutes to ready box.
- 10.2.4.21 Install weapons enclosure bag.
- 10.2.4.22 Close Gunner's Sight Shield

10.2.5 BARREL.

- 10.2.5.1 Rotate turret so that barrel is over front of vehicle.

- 10.2.5.2 Turn TURRET POWER circuit breaker OFF.
- 10.2.5.3 Turn WEAPON POWER circuit breaker OFF.
- 10.2.5.4 Position TURRET DRIVE LOCK to LOCK.
- 10.2.5.5 Locate ALIGN arrow stamped into barrel.
- 10.2.5.6 Rotate barrel so that ALIGN arrow is on top.

WARNING

Barrel weighs 89 pounds and will require two people to lift it.

- 10.2.5.7 Insert barrel into breach.
- 10.2.5.8 Rotate barrel clockwise 1/4 turn until barrel clicks into place.
- 10.2.5.9 Verify that the LOCKED arrow is on top of barrel.
- 10.2.5.10 Verify that the barrel is latched by trying to turn it counterclockwise.

10.3 PERFORM M240 COAX REMOVAL, DISASSEMBLY, ASSEMBLY AND INSTALLATION PROCEDURES.

10.3.1 Removal.

- 10.3.1.1 Turn TURRET POWER circuit breaker OFF.
- 10.3.1.2 Turn WEAPON POWER circuit breaker OFF.
- 10.3.1.3 Position TURRET DRIVE LOCK to LOCK.
- 10.3.1.4 Unzip the weapons enclosure bag.
- 10.3.1.5 Disconnect electrical connection from solenoid.
- 10.3.1.6 Pull charging handle to the rear.
- 10.3.1.7 Position manual safety to S (safe).
- 10.3.1.8 Raise cover assembly.
- 10.3.1.9 Remove ammo belt.
- 10.3.1.10 Raise feed tray.
- 10.3.1.11 Visually and physically verify that chamber is empty.
- 10.3.1.12 Remove feed chute.
- 10.3.1.13 Remove link chute.

- 10.3.1.14 Remove gun-cradle securing pin from rear of COAX.
- 10.3.1.15 Pull and hold cradle release lever.
- 10.3.1.16 Lift rear of COAX and pull away from gun mount.
- 10.3.1.17 Release cradle release lever.
- 10.3.1.18 Remove COAX from cradle.

10.3.2 COAX disassembly procedure.

- 10.3.2.1 Charge, clear (visually inspect chamber), and safe gun.
- 10.3.2.2 Remove barrel.
 - 10.3.2.2.1 Position safety to S (safe).
 - 10.3.2.2.2 Depress barrel locking latch and hold.

WARNING

Wear asbestos gloves if barrel is hot.

- 10.3.2.2.3 Turn barrel release to upright position.
 - 10.3.2.2.4 Remove barrel.
 - 10.3.2.3 Position manual safety to F (fire).
 - 10.3.2.4 Pull charging handle to rear. Pull trigger and ease bolt forward.
 - 10.3.2.5 Depress trigger pin spring and remove pin. Pull trigger and frame assembly down and back. Pull charging handle through cable guide.
 - 10.3.2.6 Depress backplate latch.
 - 10.3.2.7 Lift and remove backplate.
 - 10.3.2.8 Press driving spring in, up, and out.

CAUTION

Do not stand behind driving spring during removal.

- 10.3.2.9 Raise cover assembly. Place left hand over backplate opening to catch operating rod and bolt assembly. Pull charging handle back, then pull operating rod and bolt assembly out.
- 10.3.2.10 Close cover. Push out cover hinge spring pin as far as possible with the back of buffer. Remove pin with fingers. Remove cover assembly and feed tray.
- 10.3.3 COAX assembly procedure.
 - 10.3.3.1 Position feed tray and cover assembly; push cover assembly forward; close cover and insert cover hinge spring pin.
 - 10.3.3.2 Slide trigger and frame assembly into place. Insert trigger pin; slide charging handle through cable guide.
 - 10.3.3.3 Open cover assembly. Extend bolt to unlocked position. Pull trigger. Set operating rod and bolt assembly on top of rails (receiver), then push all the way in. Close cover and lock.
 - 10.3.3.4 Insert driving spring into operating rod. Push in fully and lower to set the stud in hole of receiver.
 - 10.3.3.5 Install backplate (buffer) and make sure it latches.

NOTE

Top of buffer should be flush with top of receiver.

- 10.3.3.6 Insert barrel fully into receiver and rotate barrel release latch to downward position to lock.
- 10.3.3.7 Perform function check.

- 10.3.4 COAX installation procedure.
- 10.3.4.1 Turn TURRET POWER circuit breaker OFF.
 - 10.3.4.2 Turn WEAPON POWER circuit breaker OFF.
 - 10.3.4.3 Verify TURRET PWR indicator not lit.
 - 10.3.4.4 Verify WEAPON PWR indicator not lit.
 - 10.3.4.5 Position TURRET DRIVE LOCK to LOCK.
 - 10.3.4.6 Lay COAX in cradle guide channel.
 - 10.3.4.7 Slide COAX forward.
 - 10.3.4.8 Seat rear of COAX in cradle guide channel.
 - 10.3.4.9 Connect link chute.
 - 10.3.4.10 Install and lock gun-cradle securing pin.
 - 10.3.4.11 Connect feed chute.
 - 10.3.4.12 Place the charging handle in the weapons enclosure bag.

NOTE

Ensure charging cable is not in the way.

- 10.3.4.13 Zip the weapons enclosure bag closed.

- 10.3.5 M240 COAX rate of fire adjustment procedure.
- 10.3.5.1 Perform COAX removal procedure.
 - 10.3.5.2 Perform COAX barrel removal procedure.
 - 10.3.5.3 Remove gas regulator collar from the gas port area.
 - 10.3.5.4 Remove gas regulator plug.
 - 10.3.5.5 The gas regulator plug will adjust to one of the three positions. Replace gas regulator plug so that the selected gas inlet hole on the regulator plug faces the barrel.
 - 10.3.5.6 Replace collar.
 - 10.3.5.7 Perform barrel installation procedure.
 - 10.3.5.8 Perform COAX installation procedure.

10.4 PERFORM M36E1 SIGHT (GUNNER'S AND COMMANDER'S) REMOVAL/INSTALLATION PROCEDURES.

10.4.1 Removal procedure.

- 10.4.1.1 Turn AUXILIARY POWER circuit breaker OFF.
- 10.4.1.2 Verify AUXILIARY PWR indicator not lit.
- 10.4.1.3 Release expansion pin lock.
- 10.4.1.4 Rotate expansion pin 90° and remove.
- 10.4.1.5 Remove elevation linkage from elevation arm assembly.
- 10.4.1.6 Disconnect electrical connectors from sight head assembly.
- 10.4.1.7 Remove lamp housing from dovetail slot on sight head assembly.
- 10.4.1.8 Secure nightsight with hand to prevent it from falling.
- 10.4.1.9 Loosen front and rear latches to release nightsight elbow and remove nightsight elbow from sight head assembly.

CAUTION

Exposure of nightsight to sunlight or other bright light will damage image intensifier. Keep shield over objective opening until ready for use.

- 10.4.1.10 Secure daysight with hand to prevent it from falling.

NOTE

If removing gunner's sight, remove coax solid feed chute.

10.4.1.11 Disengage left and right latches to release daysight elbow and remove daysight elbow from sight head assembly.

CAUTION

Do not permit the elevation arm assembly to snap to a stop when removing sight. Serious damage to equipment may occur.

10.4.1.12 Loosen wing nuts and align vertically with slots.

10.4.1.13 Pull back on head rest assemblies to avoid interference with sight head assembly.

10.4.1.14 Secure sight head assembly with hand to prevent it from falling.

10.4.1.15 Release safety latch.

10.4.1.16 Remove sight head assembly from sight mounts.

10.4.1.17 Install day/night sight elbows into sight head assembly.

10.4.2 Installation procedure (gunner's and commander's).

10.4.2.1 Disengage latches to remove day/night sight elbows from sight head assembly.

10.4.2.2 Loosen wing nuts and position them vertically to align with slots in sight.

10.4.2.3 Slide head assembly into sight mount. Seat properly. Safety latch should snap into place.

NOTE

Ensure that the latch is secure and that heads are properly mounted. Water seals will create resistance to seating.

10.4.2.4 Tighten wing nuts.

10.4.2.5 Slide daysight elbow into sight head assembly. Seat properly.

10.4.2.6 Engage left and right latches to secure daysight elbow.

10.4.2.7 Slide nightsight elbow into sight head assembly. Seat properly.

CAUTION

Exposure of nightsight to sunlight or other bright light will damage image intensifier. Keep shield over objective opening until ready for use.

10.4.2.8 Engage front and rear latches to secure nightsight elbow.

10.4.2.9 Install lamp housing into dovetail slot on sight head assembly.

10.4.2.10 Connect electrical connectors to sight head assembly.

10.4.2.11 Align elevation linkage to elevation arm assembly.

10.4.2.12 Install expansion pin and rotate pin handle 90° to secure.

11. PERFORM OPERATOR TROUBLESHOOTING PROCEDURES

11.1 TROUBLESHOOT M242 MAIN GUN FAILURE TO FIRE.

- 11.1.1 Verify safety is in FIRE (inline).
- 11.1.2 Verify WEAPON POWER circuit breaker is on.
- 11.1.3 Verify WEAPON PWR indicator is lit.
- 11.1.4 Verify WPN ARM switch is in ARM.
- 11.1.5 Verify MAIN GUN indicator lit.
- 11.1.6 Verify MAIN GUN connector and connector plugs are properly seated.
- 11.1.7 Verify SEAR indicator is lit. If not check bolt position indicator and perform appropriate immediate action.

11.2 TROUBLESHOOT M240 COAX FAILURE TO FIRE.

- 11.2.1 Verify manual safety switch in F (Fire).
- 11.2.2 Charge COAX.
- 11.2.3 Verify round in feed tray.
- 11.2.4 Verify WEAPON POWER circuit breaker ON.
- 11.2.5 Verify WEAPON PWR indicator lit.
- 11.2.6 Ensure WPN ARM switch is in ARM.
- 11.2.7 Verify COAX indicator lit.
- 11.2.8 Verify electrical connector is properly seated to the COAX solenoid.
- 11.2.9 Verify COAX is properly lubricated.
- 11.2.10 Check that ammo links are not binding in link chute.
- 11.2.11 Check that feed chute is latched in place at feeder tray and at coax solid feed chute. If necessary latch feed chutes in place.
- 11.2.12 Check to see if ammo is binding in box.
- 11.2.13 Check that feed chute has no binding ammo, broken ammo belt or separated ammo belt. If necessary remove and replace ammo in feed chute.

11.3 TROUBLESHOOT M257 GRENADE LAUNCHER FAILURE TO LAUNCH.

- 11.3.1 Verify WEAPON POWER circuit breaker ON.
- 11.3.2 Verify WEAPON PWR indicator lit.
- 11.3.3 Verify LEFT/RIGHT or both SALVO switches are ON.

- 11.3.4 Verify READY indicator lit.
- 11.3.5 If still unable to launch refer to immediate action for GRENADE LAUNCHER failure to LAUNCH.

11.4 CYCLE M242 BOLT TO SEAR, FEEDER INSTALLED.

- 11.4.1 Unlock locking ring on power cable and unplug cable.
- 11.4.2 Position safety to SAFE (crosswise).
- 11.4.3 Insert handcrank into manual drive gear hub.
- 11.4.4 Press in and hold sear release lever.
- 11.4.5 Turn handcrank clockwise. Let go of sear release lever when bolt position indicator clears MISFIRE position.
- 11.4.6 When bolt position indicator reaches SEAR position, remove handcrank from manual drive gear hub.
- 11.4.7 Plug power cable in and secure locking ring.

11.5 CYCLE M242 BOLT TO SEAR, FEEDER REMOVAL PROCEDURE.

- 11.5.1 Perform feeder removal procedure.
- 11.5.2 Push in drive shaft knob button and turn drive shaft knob in direction of arrow on knob until it stops turning.
 - 11.5.2.1 If drive shaft knob stops turning, go to Step 11.5.3.
 - 11.5.2.2 If drive shaft knob does not stop turning, press hard on upper right tab of sear retractor lever to release sear retractor lever.

NOTE

Bolt will not lock in sear when retractor lever is engaged.

- 11.5.3 Turn drive shaft knob toward opposite direction of arrow on knob.
 - 11.5.3.1 If drive shaft knob does not turn, bolt is locked in SEAR.
 - 11.5.3.2 If drive shaft knob does turn, bolt is not locked in SEAR. Notify organizational maintenance.

11.6 TIME M242.

11.6.1 Time feeder.

11.6.1.1 Perform feeder removal procedure.

11.6.1.2 Place feeder on deck with worm nut shaft accessible to operator.

11.6.1.3 Press in on timer lift rod and turn worm nut shaft counterclockwise. Release timer lift rod after one turn.

11.6.1.4 Continue to turn worm nut shaft until bolt position indicator stops in SEAR position and timer lift rod pops out.

11.6.1.4.1 If timer lift rod does not pop out or bolt position indicator does not stop in SEAR position, notify organizational maintenance.

11.6.2 Time receiver.

11.6.2.1 Perform cycle M242 Bolt to Sear, Feeder Removal Procedure (11.5).

APPENDIX K

**INDIVIDUAL SUBTASK/STEP TARGET
DESCRIPTIONS BY GUNNERY CATEGORY**

INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY (CON'T)

FUNCTION PERFORMED BY TARGET

TARGET ACQUISITION TASKS

3. Basis for making a decision about the type of target and producing a description to include its location and actions (5.5.3; 5.5.4)

TARGET/ENVIRONMENTAL FACTORS

<u>APPARENT VISUAL SIZE</u>	<u>OBJECT/SHAPE VISIBLE DETAILS</u>	<u>OBJECT MOTION</u>	<u>AMBIENT ILLUMINATION</u>	<u>TARGET/BACKGROUND CONTRAST</u>	<u>TARGET DURATION</u>
Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Present side, oblique and frontal views of threat targets under varying degrees of terrain, vegetation, and atmospheric masking/obscuration; level of detail should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters	Stationary and moving (up to speeds of 30-40 mph)	Normal day level	Low to high contrast	Continuous except when masked by terrain, vegetation or atmospheric obscuration
Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition range, e.g. 500 to 2000 meters	Present side, oblique and frontal views of threat (or threat and friendly) targets under varying degrees of terrain, vegetation, and atmospheric masking/obscuration; level of detail should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters	Stationary and moving (up to speeds of 30-40 mph)	Night level	Low to high contrast	Continuous except when masked by terrain, vegetation, or atmospheric obscuration

4. Basis for practicing night visual detection skills (unaided vision) and using night vision sight (5.4.1; 5.4.3)

APPENDIX K

INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY

FUNCTION PERFORMED BY TARGET

TARGET/ENVIRONMENTAL FACTORS

PREPARE TO FIRE TASKS

APPARENT VISUAL SIZE

OBJECT/SHAPE VISIBLE DETAILS

OBJECT MOTION

AMBIENT ILLUMINATION

TARGET/BACKGROUND CONTRAST

TARGET DURATION

1. Reference object for bringing sight into focus (4.6.4, 4.8.12)

Image presented an sight should subtend in angle equal to that subtended by a typical threat vehicle at 1000 meters

Object edges should be distinct and well defined

Stationary

Both day and night levels

High to maximize visibility

Continuous

2. Reference point for LOS adjustments (4.7.6)

Image presented an sight should subtend in angle equal to that subtended by a typical threat vehicle at 1000 meters

A single distinct feature or point should be present that can be consistently seen by an observer through the sight

Stationary

Normal day level

High to maximize visibility

Continuous

3. Aiming point for boreighting and zeroing main gun (3.5.1, .4, .6, .8, .10; 3.6.2, .4, .7, .9, .11, .12, .13, .15, .16)

Image presented in sight should subtend an angle equal to that subtended by a typical threat vehicle at 1000 meters

A single distinct feature or point should be present that can be consistently seen by an observer through the sight

Stationary

Normal day level

High to maximize visibility

Continuous

TARGET ACQUISITION TASKS

1. Basis of detecting and making a decision about target type (friend vs enemy) (5.5.1)

Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat and friendly vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters

Present side, oblique and frontal views of threats under varying degrees of terrain, vegetation, and atmospheric masking/obscuration; level of detail should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters

Stationary and Normal day level moving (up to speeds of 30-40 mph)

Low to high contrast

Continuous except when masked by terrain, vegetation or atmospheric obscuration

2. Basis for making a decision about target lethality (5.5.2)

Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters

Present side, oblique and frontal views of threat targets under varying degrees of terrain, vegetation, and atmospheric masking/obscuration; level of details should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters

Stationary and moving (up to speeds of 30-40 mph)

Low to high contrast

Continuous except when masked by terrain, vegetation or atmospheric obscuration

INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY (CON'T)

FUNCTION PERFORMED BY TARGETTARGET/ENVIRONMENTAL FACTORS

<u>FIRE COMMAND TASKS</u>	<u>APPARENT VISUAL SIZE</u>	<u>OBJECT/SHAPE VISIBLE DETAILS</u>	<u>OBJECT MOTION</u>	<u>AMBIENT ILLUMINATION</u>	<u>TARGET/BACKGROUND CONTRAST</u>	<u>TARGET DURATION</u>
5. Serves as reference point toward which turret is slewed (6.1.5.1)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicle over normal combat acquisition ranges, e.g., 500 to 2000 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscuration
6. Serves as object for Gunner to find in his gunsight (6.1.5.2, 6.3.5.5)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscuration
7. Serves as object at which weapon is aimed, tracked, and fired (6.3.5.8)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscuration
8. Serves as reference point which is used to determine if fired rounds have hit their mark (6.1.8., 6.3.5.9)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 200 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscuration

INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY (CON'T)

FUNCTION PERFORMED BY TARGETTARGET/ENVIRONMENTAL FACTORS

<u>FIRE COMMAND TASKS</u>	<u>APPARENT VISUAL SIZE</u>	<u>OBJECT/SHAPE VISIBLE DETAILS</u>	<u>OBJECT MOTION</u>	<u>AMBIENT ILLUMINATION</u>	<u>TARGET/BACKGROUND CONTRAST</u>	<u>TARGET DURATION</u>
1. Stimulus for issuing alert (6.1.1, 6.3.5.1)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to speed of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
2. Basis for making a decision about the type of ammunition and rate of fire to select (6.1.2)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Present side, oblique and frontal views of threat targets under varying degrees of terrain, vegetation and atmospheric masking/obscuration; level of detail should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
3. Basis for making a decision about nature of target (armored car, tracked vehicle, troops, etc.) (6.1.3, 6.3.5.4)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Present side, oblique and frontal views of threat targets under varying degrees of terrain, vegetation and atmospheric masking/obscuration; level of detail should reflect what the human eye (both aided and unaided) can discern at ranges from 500 to 2000 meters	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
4. Stimulus for making an unaided range estimate from LAV to object (6.1.5.1)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	No requirement	Stationary or moving (up to speeds of 30-40 mph)	Both day and night levels	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants



INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY (CON'T)

FUNCTION PERFORMED BY TARGET

TARGET FIRING TASKS

TARGET/ENVIRONMENTAL FACTORS

APPARENT VISUAL SIZE	OBJECT/SHAPE VISIBLE DETAILS	OBJECT MOTION	AMBIENT ILLUMINATION	TARGET/BACKGROUND CONTRAST	TARGET DURATION
1. Stimulus for making an unaided range estimate from LAV to object (6.5.1; 6.6.1)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	No Requirement	Stationary or moving (up to night level speeds of 30-40 mph)	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
2. Stimulus for making an estimate of rate of movement (6.5.2; 6.6.2; 6.2.5)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	No Requirement	Moving (up to night level speeds of 30-40 mph)	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
3. Serves as object at which weapon is aimed, tracked, and fired (6.5.3, .4 .5, .6, .7; 6.6.3, .4, .5, .6, .7; 6.6.3, .4, .5, .6, .7; 6.2.1; 6.2.9; 6.3.2; 6.4.2.1, .2, .3)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Specific shape and internal detail only as needed for recognition as a target	Stationary or moving (up to night level speeds of 30-40 mph)	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants
4. Stimulus for making a range estimate from LAV to object using stadia reticle (6.2.2)	Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	Present side, oblique and frontal views of threat targets under varying degrees of terrain, vegetation and atmospheric masking/obscuration; no internal detail is needed	Stationary or moving (up to night level speeds of 30-40 mph)	Low to high contrast	Continuous except as masked by terrain, vegetation or atmospheric obscurants

INDIVIDUAL SUBTASK/STEP TARGET DESCRIPTIONS BY GUNNERY CATEGORY (CON'T)

FUNCTION PERFORMED BY TARGETTARGET FIRING TASKS

5. Stimulus for making an estimated required lead angle (6.2.6)

TARGET/ENVIRONMENTAL FACTORS			
APPARENT VISUAL SIZE	OBJECT/SHAPE VISIBLE DETAILS	OBJECT MOTION	AMBIENT ILLUMINATION
Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters	No requirements	Moving (up to speeds of 30-40 mph	Both day and night level

TARGET/BACKGROUND CONTRAST

Low to high contrast

TARGET DURATION

Continuous except as masked by terrain, vegetation or atmospheric obscurants

6. Stimulus for deciding if range from LAV to object is within battlesight limits using the stadia reticle (6.3.4)

Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters

No requirements

Stationary or moving (up to speed of 30-40 mph

Low to high contrast

Continuous except as masked by terrain, vegetation or atmospheric obscurants

SENSING BOUNDS TASKS

1. Serves as reference point which is used to determine if rounds have hit their mark (6.4.1, 6.4.2)

Images presented in sight or to unaided eye should subtend angles equal to that subtended by the full range of threat vehicles over normal combat acquisition ranges, e.g., 500 to 2000 meters

Specific shape and internal detail only as needed for recognition as a target

Stationary or moving (up to speed of 30-40 mph

Low to high contrast

Continuous except as masked by terrain, vegetation or atmospheric obscurants

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